SANITARY INSPECTOR'S MANUAL

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Louisiana State Department of Health

NEW ORLEANS, LA.

Printed by PEERLESS PRINTING CO.
NEW ORLEANS, LOUISIANA

Prepared, 1942

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Contents

SUPPLEMENTS

ERRORS:

Page 24, paragraph 3, line 4, omit word ratio.

Page 51, paragraph 6, line 1 -- service should be surface.

Page 62, paragraph XI -- Vistors' should be Visitors .

Page 95, paragraph 5, line 1 -- Manhold should be Manhole.

Page 106, paragraph 14, line 1 -- unaccuracies should be inaccuracies.

Page 235, end of page, page reference -- 234 should be 236.

Page 240, Application for Permits belongs with the succeeding Procedure for Registration, Collection of Fees, Issuance of Permits, Closure, Seizure of Foods and Drugs.

Page 272, paragraph 3, line 1 -- preimarily should be primarily.

Pages 275 and 276, pinworms, whipworms, tapeworms, ringworms are incorrectly written as two words.

Pages 322 and 323, 324. This table of Recommended Proportions of Water to Cement and Suggested Trial Mixes will be more useable if vertical lines are drawn.

Page 336 -- Present address of Journal of the American Public Health Association is 1790 Broadway.

Foreword

In this book an effort has been made to assemble data that might be useful to the sanitarian. It was completed early in 1942 but due to the conditions of the times, it is in some respects already out-dated. In particular, the sanitarian in Louisiana should check against the Sanitary Code to see whether each book reference is still valid. For example, pages 117 to 121 were printed before Chapter V on Milk and Milk Products was adopted by the Board of Health on October 8, 1942. Chapter XI on Camps was adopted on April 10, 1942 and Chapter XXIV on Burial, Transportation, Disinterment or other Disposition of Dead Human Bodies was adopted on April 18, 1942. The whole Code is in the process of revision.

Foreword

[illegible]

The Sanitarian: His Work and Place

HISTORICAL HIGH POINTS OF SANITATION

Sanitation, from the earliest biblical times has been a monumental bulwork of public health. The Mosaic Laws were made up of:

1. Crude sanitary practices
2. Crude personal hygiene practices
3. Quarantine and isolation

During the Grecian period, the practices of personal hygiene predominated over all other community health measures. With the rise of the Roman Empire developed a very extensive program of sanitation which outshined all other health practices. The following are some of the measures practiced by the Romans:

1. Paving
2. Drainage
3. Sewerage
4. Scavenging
5. Control against water supply pollution
6. Sanitary construction of buildings
7. Nuisance control
8. Destruction of unsound foods

After the fall of Rome, the oncoming Medieval Period was accompanied by an almost complete disuse of all health measures with exception of quarantine and isolation. This was a period of asceticism in which regard for human welfare among the leadership of the times as about nil. Grim necessity forced the acceptance of quarantine and isolation measures.

The beginning of the Renaissance Period again found sanitation growing into the principal form of community health practices. In 1297 in England, regulations were passed for keeping fronts of houses clean. In 1345, pollution of the Thames river began to receive official attention. In 1350, in France, the first sanitary police program was established.Here the seed was planted for the development of the modern sanitarian. These police were given the duty to guard that:

1. No hogs should be kept in cities
2. Streets should be cleaned
3. Offal removed
4. Butchers should not sell meat more than two days old in winter, and one and one-half days old in summer.
5. Fish should be sold on the same day caught

The first important development in the great sanitary awakening of modern times began with the humanitarian reforms of 1774 in England. At this time, John Howard presented the House of Commons with his exhaustive study on insanitary and inhuman conditions in the prisons, and forthwith the Prison Reform Laws were passed which provided that prisons were to be whitewashed yearly, regularly washed and ventilated; rooms were to be set apart for the sick, hot and cold water baths provided and in case of necessity, clothes were to be

lent to prisoners. This law formed a stimulating point for introducing into the mind of the British public the fundamental conceptions of sanitation.

In 1779 Johann Peter Frank, a great German physician, published his work on public hygiene in which he ingeniously and at great length discussed such subjects as sewage control and water supply control. Indeed he stressed most of the important phases of sanitation. He, himself, served as sanitary officer for Lombardy in 1786 and later served in the hospitals of Vienna. His influence touched the sanitary developments in Germany, Scandinavia, and Russia.

Although England took the lead in the great sanitary awakening, the United States, still an infant nation, began to follow closely on the heels of the mother country in matters of public health. In 1798 the Marine Hospital Service was established under the Treasury Department, which later became the United States Public Health Service. At its inception, this organization served only as a medical service for seamen, but soon took on quarantine functions. It was not till about the beginning of the present century that this organization began actively to participate in other sanitary problems other than quarantine.

The industrialization of England brought with it great demands for more and cheaper labor. There followed a system of apprentice slavery, so revolting in its details as to be almost unimaginable in the England which was taking the lead in reforming prisons, and in abolishing African slave trade. Pauper children (and they were frightfully numerous)were the most victimized. Under the insanitary conditions which surrounded these wretched children, both in the factory and in the barracks (where they slept by relays in filthy beds which were never allowed to cool), it is small wonder that epidemic disease raged. The first impetus toward reform was not altruistic but inspired by necessity of preventing such costly epidemics. In 1802 Parliament passed the first British factory act which provided for whitewashing factories, better clothing, feeding, and instruction of apprentices, reduction of working hours from the inhuman sixteen to twenty hours to twelve hours and abolition of night work for children. This was the beginning of a long series of British factory acts which finally led to tolerable protection for the health of the industrial workers. The real glory for the development of these important reforms must go not to Parliament but to struggles waged by workers themselves for the bettering their lot. To this, history will amply attest. These struggles led to further reforms such as the comprehensive Factory Act in 1833, the Ten-Hour Bill in 1847, and the Factory Consolidation Act in 1878.

The above conditions alluded to forced the creation of a Poor Law Board in 1834, headed by Edwin Chadwick, a lawayer and humanitarian. In the epoch-making report on the "Sanitary Conditions of the Labouring Population of England", presented by the Poor Law Commission in 1842 to the government, it was pointed out that much of the illness producing destitution was caused by the wretched housing and insanitation of crowded populations. On the basis of this study, the First Public Health Act in England was passed by Parliament in 1848.

The same struggle of the working population was re-enacted in the United States a half century later and similar labor legislation formulated and passed around the turn of the Twentieth Century.

Dr. John Snow's studies (published in 1855) of the sanitary conditions related to spread of cholera epidemics in England 1848-49 and 1853-54 and his epidemiological proof of its water-borne character was indeed a milestone in public health development.

Inspired by the work of Chadwick and Simon in England, Samuel Shattuck in the United States completed his sanitary survey in 1850, entitled "Report of the Massachussets Sanitary Commission", which was even more comprehensive in its recommendations than those of his English colleagues. The clarity of his prophetic vision in his recommendations for establishment of state health departments with complete programs in public health including sanitation of towns and buildings and the organization of a system of sanitary police in state and local health departments, remains the first truly great land mark in public health development in the United States.

Following the two appalling yellow fever epidemics in Louisiana in 1853 and 1854, there was organized a joint state and city (New Orleans) Board of Health in 1855 which was in reality a quarantine board. This was the first time that a state in the United States actively participated in public health.

Through the efforts of Dr. John Simon a series of public health laws were passed in England of which the Great Sanitary Act of 1866 is perhaps the most notable. This act provided power to local authorities to suppress all kinds of nuisances, to restrict the sale and purchase of poison, to prohibit certain poor water supplies, to make it a public offense to sell adulterated food or drink or medicine, to provide organized medical assistance during emergencies, and to require free vaccination. At the same time Dr. Stephen Smith (founder of the American Public Health Association 1872) was formulating the Metropolitan Health Bill (New York City) guided by the English Public Health Laws, and in 1866 he succeeded in having the bill passed which served as a model in the United States for giving public health authorities supreme powers in carrying on activities in relation to any matter "dangerous to life and detrimental to health" of the community.

Dr. William Budd was the first one to show that typhoid can be conveyed by water. He taught that the infective material of typhoid might get into the body by swallowing. His work, "Typhoid Fever, Its Nature, Mode of Spreading, and Prevention" was published in 1873. He was a colleague of Dr. Snow and independently reached the same conclusions about cholera in 1849 as did Snow.

Max Von Petten Kofer's (1818-1901) work on the ventilation of dwelling houses, on clothing, and on the soil and the relation of ground-water to disease, entitles him to the honor of being considered the founder of experimental hygiene. He was in the thick of the fight against cholera and typhoid fever for 40 years. In the latter half of the 19th century, he all but rid the city of Munich of typhoid fever through the introduction of a proper system of drainage. His leadership stimulated the development of sanitary work, especially hygiene.

In 1871, the Royal Sanitary Commission in its report summarized the fundamental health essentials under the following eleven heads, a meagre program from present day standpoint, but a vast advance over the ideals of 30 years earlier when Chadwick presented his survey of sanitary conditions to the English government: (1) The supply of wholesome and sufficent water for drinking and washing. (2) The prevention of the pollution of water. (3) The provision of sewerage and utilization of sewage. (4) The regulation of streets, highways and new buildings. (5) The healthiness of dwellings. (6) The removal of nuisances and refuse and consumption of smoke. (7) The inspection of food. (8) The suppression of causes of disease and regulations in case of epidemics. (9) The provision for burial of the dead without injury to the living. (10) The regulation of markets, etc., public lighting of towns. (11) The registration of deaths and sickness.

With the development of Bacteriology, beginning with the discoveries of Pasteur,sanitary techniques developed with unparalleled swiftness, and gave birth to the field of modern sanitary engineering.

Although filtration of water was introduced by James Simpson for the London Water Supply as early as 1829, the purpose was primarily esthetic and not sanitary. With the introduction of the solid culture media method of Koch for growing bacteria, and its application to the enumeration of bacteria by P. F. Frankland (England - 1885), it became evident that filters were removing bacteria as well as visible impurities. The cholera epidemic at Hamburg, Germany in 1892, in which the neighboring town of Altona was effectively protected by filtration of the supply, furnished convincing evidence of the value of the process. The epidemic of typhoid fever at Lowell and Lawrence, Massachussetts in 1890-91 and the subsequent construction of the Lawrence Filter in 1893 and the Albany Filter in 1899 led to a rapid popularization of the English or slow-sand filter in this country. The number of people in cities in the United States over 2,500 population who had access to filtered water was: 1880 --- 30,000 people; 1890 --- 310,000 people; 1900 --- 1,860,000 people; 1910 --- 10,805,000 people; 1920 --- over 20,000,000 people.

The treatment of water by chlorination was first tried by DeMorveau in France, and by Cruikshank in England about the year 1800. The first systematic use of chlorine in water is due to Houston and McGowan in England in 1904-5.

Coagulation methods for the treatment of water were employed from very early times. In 1893, D'Arcet gave account of the purification of Nile water by adding alum and filtering through small household filters.

Sewage treatment began in the latter part of the 19th Century. Although land irrigation with sewage was an old and effective process, its use for sewage purification in England was retarded by the absence of extended sand beds near most of the British cities. Consequently a more intense filtration on smaller areas came into use and an intermittent

filtration of greater intensity, through sand, was introduced on recommendations of Sir Edward Frankland (Father of P. F. Frankland) 1868-74. In 1854, an English Royal Commission used chlorination in the treatment of sewage in London. In 1891 fermentation of stored sewage (septic tanks) was developed by Scott-Moncrieff, by Talbot (Illinois) 1894, by Cameron (England) 1895. In 1892, the trickling filter was introduced for sewage treatment by Lowcock in England. In 1909 Karl Imhoff (Germany) devised the sewage treatment tank known as the Imhoff tank.

Modern Pure Food Laws began with a food control law passed in England in 1875. This was followed by similar laws in Germany in 1879. In 1881 New York State enacted the first effective Food Control Laws in the United States. In 1906 the Federal Food Laws in the United States were enacted.

In 1874, Fryer, in England, built the first furnace for effectively destroying refuse.

In 1881, Hart compiled and reported a long list of milk epidemics, furnishing convincing evidence to the world of the vital relationship of milk to public health.

In 1886, Soxhlet, in Munich, recommended that all cows' milk fed to infants should be boiled or sterilized for at least 35 or 40 minutes to kill the germs contaminating it.

In 1890 Babcock introduced his method determining the percentage of butterfat in milk and revolutionized the milk industry economically. In 1892, the movement toward certified milk was inaugurated by Coit. In 1908, the city of Chicago adopted the first ordinance requiring the pasteurization of all milk except milk of the highest sanitary quality.

In 1910, the Rockefeller Sanitary Commission entered the public health field with the principle interest in hookworm control. In 1914, the United States Public Health Service began its studies on typhoid fever control in rural areas. These two movements motivated the development of County (or Parish) Health Units. In 1911, Guilford County, North Carolina, and Yakima County, Washington, organized the first county health units in the United States. The first health units organized in Louisiana took place in 1921. They were Caddo, DeSoto, Natchitoches, Ouachita and Washington.

In 1935 was passed the Social Security Act which established the Social Security Board under which the Federal Security Agency was to function. This is another of the great milestones in Public Health development in United States, because practically all federal organizations whose functions were associated with Health and Welfare were unified under this Agency. In 1939 the United States Public Health Service was transferred from the Treasury Department to the Federal Security Agency and at present this agency, actually or potentially, has spread its ramifications into every sphere of the modern Public Health Program, from sanitation to old-age pensions. This agency is due to become in the near future one of the most important and most extensive agencies of our government.

WHO IS THE SANITARIAN?

The early practices of health organizations were such that the "Inspector" played the predominant role in public health work. Many health officers were laymen in the early days, and there are still lay health officers in some places in the United States. They have played a leading role in public health development. The sanitarian has the oldest and proudest history of all public health personnel. That public health today is no longer directed by lay people is a fine commentary on its growth and development. Its leaders today include scientists of every profession. Medical men have become the health officers, and the sanitary engineer has developed from the scientific broadening of the sanitary inspector of the past. The medical and engineering sciences have found a common ground in public health.

In the swiftly moving currents of public health development, the medical health officer, the sanitary engineer, and the nurse have found professional places. The medical officer and sanitary engineer have been more or less relieved of their "dirty work" by the nonprofessional, less academic inspector. Not long ago the public health inspector was an untrained layman who cleaned up nuisance complaints too menial for the dignity of the physician and engineer. But science has enriched our understanding of sanitation to the point where our total environment has come under the scrutiny of the science of public health. It has created an extensive and detailed job demanding the ingenuity and scientific training of the sanitarian, so that more and more he is becoming professionalized.

Water supplies and excreta disposal must be controlled; the handling of milk, meat, and other foods must be supervised; building construction, lighting, heating and ventilation

inspection called for continuous vigilance; mosquitoes, flies, and other insects must be abated; rat control measures must be directed. The field work necessary to maintain these and other control measures is interminable. White collars can not always be worn to do the job on the spot. The highly trained sanitary engineer is a scarcity and his talents are best used in directing and developing the technical aspects of sanitation. It falls upon the less technically trained, less scarce, but hardy, intelligent mass of well educated laymen to carry on in this field work. The sanitary inspector is such an individual.

Recently the terms sanitarian, sanitary inspector, sanitary officer, have come in for definition and classification. The American Public Health Association classifies the sanitarian as a professional health worker having a Bachelor's degree and one year course in public health, and classifies other sanitary workers with less academic training as sanitarian assistant. Thus, sanitary workers are divided into three categories: (1) Sanitary Engineers, (2) Sanitarians, (3) Sanitarian Assistants.

The experience of Louisiana is such that the three categories are quickly being contracted into two. This is coming about by raising the standards of the inspector so that in the past two years more than 50% of the "inspectors" taken into sanitary work in the state had a Bachelor's degree. These men do essentially the same work as the "inspector" except that they have better background for understanding the theoretical basis of sanitary science. Experience has further taught that there is no necessity for three categories of sanitary workers. The sanitary engineer and the sanitary inspector are sufficient. Since the sanitary inspector is more and more approximating the qualifications of the sanitarian rather than the sanitarian assistant, in Louisiana inspectors are called "sanitarians".

Thus, the work of the sanitarian is diverse and manifold. It requires intelligence, social consciousness, a deep sympathy for people and their lot, teaching ability, a technique for handling and persuading people, a good education, and an understanding of such basic sciences as physics, chemistry, and biology. It is clear that the trained sanitarian is neither a professional man nor a layman. He is an intermediate between the two - a skilled worker - an individual with a highly important vocation dedicated to community service. It is a position replete with dignity and respect, and approaches professional levels.

The qualifications of a sanitary worker as given by the American Public Health Association's Committee on Professional Education are as follows:

A. Educational requirements of sanitarians - the committee recommends: (1) That the educational requirements be a Bachelor's degree from a recognized institution of learning, followed by at least a one year course, or its equivalent, in certain subjects necessary for one entering the public health field. Under-graduate work should include science courses, particularly biology and chemistry. (2) The subjects required should be such as to give general knowledge of health department activities and include some intensive instruction along one or more lines of health work. The intensive instruction might well be grouped under the three headings: general sanitation, sanitary control of foods, and control of environment.

    The following general instruction is recommended: (1) Biostatistics. (2) A general knowledge of epidemiology, including methods of collecting, recording, and interpreting epidemiological information regarding those diseases toward the prevention and control of which the sanitarian would be expected to contribute. (3) Health administration sufficient to give a general knowledge of the types and methods of operation of health departments.

    Special instruction is recommended in one of the following: (1) General sanitation, including nuisances, water supply, sewage disposal, rural and recreational sanitation, mosquito control, and rodent control. (2) Sanitary control of milk and foods, including laboratory procedures and methods of protection against such diseases as may be transmitted by foods. (3) Control of the environment, to include housing, plumbing, lighting, ventilation and industrial sanitation.

It is assumed that the undergraduate course would serve as a guide to the individual in the special line of instruction selected for graduate work. Where sufficient instruction in any of the subjects listed has been obtained during the undergraduate course, such subjects need not be repeated.

The committee recommends that the title of one who has completed this formal instruction or who has acquired the equivalent through experience should be "sanitarian", with such

prefix as the training in a particular branch of public health would indicate. However, when the term "sanitarian" is used without prefix, it should designate a person who has had certain basic instruction in engineering and who later by additional work may qualify as a public health engineer.

B. Educational qualifications of sub-professional field personnel in sanitation: In small health units where each of the persons engaged in environmental sanitation must of necessity cover a wide range, the individuals employed should in all cases meet the qualifications set forth for public health engineers or sanitarians. In the larger city and county health agencies having divisions of general, food, milk and industrial sanitation, the direction of these various branches should likewise be by individuals meeting the qualifications set forth for public health engineers or sanitarians. It is realized that it may be necessary or desirable to employ or to continue to employ non-professional personnel in subordinate positions in the larger city and county health agencies until such time as public health administrators are able to require the higher standards prescribed for the public health engineer and sanitarian grades.

The committee recommends: (1) That such sub-professional personnel be given the title of sanitarian assistant rather than the title of sanitary inspector, sanitary officer, or sanitation officer. (2) That the education and experience requirements be not less than graduation from high school, and at least 2 years' experience in some line of work that has brought the individual in contact with the general public. (3) That all sub-professional personnel be given in-service training, supplemented by such short course training as may promote proficiency in performing the duties assigned. The aim of these courses should be the equivalent to a 2 year college course. Graduation from high school or its equivalent and completion of a 2 year course in an institution providing a course of instruction in public health prior to employment is considered the equivalent of 2 and 3. (4) The persons of this sub-professional group not having had instruction or experience in health work should not have passed their 35th birthday at the time of first employment.

THE RELATIONSHIP OF SANITARIAN TO OTHER HEALTH PERSONNEL

It has been accepted in most places in the United States, that the director of local health work should be a physician - a medical health officer. The entire public health program is administratively under his supervision. He is supposed to understand the causes and modes of spread of diseases (epidemiology), as well as the types of programs and techniques of administrating them in order to control the spread of disease (prophylaxis). He, therefore, is the nucleus of the public health program and he intergrates the medical, sanitary and nursing services. The administration of public health work is his responsibility -- the authority is also his. The wise health officer, of course, utilizes the experience and "brains" of his whole personnel to plan and develop health programs. The sanitarian, the nurse, the engineer, the clerk, are cogs in the mechanism of a health unit; the health officer is the spring.

There is no place in public health work for an individualistic worker; that is, some member of the personnel who thinks he or she tries only to do his or her own work and forgets about the work of the other members of the personnel. An effective public health program requires that all members of the personnel work together and each one must coordinate his work with that of other members of the personnel.

The sanitarian has a definite job to perform. He has a sanitary code to follow, a set of administrative rules to be guided by, and a director to come to for consolation, aid, and moral support. He goes about his duty from day to day, performing routine service and keeping alert for signs and symptoms of the abnormal in the environment. Several days may elapse without consultation with the health officer when a definite program is in progress without developing complications but even though nothing unusual happens, the sanitarian feels an important moral support by coming from time to time to the health officer for a chat. Most health officers are busy people and cannot always drop everything that they are doing and consult with the sanitarian or any other member of the personnel. It should be remembered that there is a time and place for everything. The sanitarian who always selects the time when the health officer is busiest to consult with him and then gets hurt and sulky because the health officer postpones the consultation, should mend his ways because such a sanitarian makes trouble in a health unit. There is a time for everything. Weekly staff meetings are held to make sure that every person in the health unit gets a chance to express himself and to find guidance and consultation.

It is imperative that the sanitarian confer with the health officer in the following circumstances: (1) New program being developed or initiated. (2) Current program being changed or modified or discontinued. (3) Decisions or acts involving legal implications,

such as a closure or seizure. (4) Giving statements of policy, procedure, or technical information to the press or at public gatherings. (5) Taking vacations or time off. (6) Leaving the parish on official duty. (7) Accepting or desiring transfer to other health units. (8) Complications between various personnel. (9) Any unusual occurrence or finding. (10) Conferring or corresponding with extra-parish health personnel concerning official matters. (11) Approving technical plans for constructing sanitary facilities.

Rather than a relationship of boss and bossed between health officer and sanitarian, it would be conducive to a pleasanter atmosphere, a greater spirit of working and getting a job done if the relationship were based on the principle of collaboration wherein everyone is working to accomplish the same end. This necessitates looking to the most highly trained collaborator for advice and direction, since he is responsible for everyone's mistakes and accomplishments.

In a health unit, the authority exercised by the sanitarian or other personnel is that which is delegated to him by the health officer. When there are several sanitarians, one will be designated as Senior or Chief Sanitarian and the other sanitarians will be guided in routine matters by the Chief who, in turn, is guided by the health officer. Thus, the authority of the Chief Sanitarian is over-ruled only by the health officer.

The relationship between sanitarian and nurse should be that of collaborators in different aspects of the same work. They should realize that their work is closely tied together, and that one is incomplete without the other. A nurse who continues to visit a home that has poor or no sanitary facilities for excreta disposal or water supply, where the family is infested with hookworm or where diarrhea and other intestinal sicknesses are prevalent, and does not confer with the sanitarian about these conditions, is not performing an efficient job, and conversely, the sanitarian who in his routine work sees sickness and debility and does not confer with the nurse, is missing an opportunity to perform a good job.

State office personnel will confer with sanitarian with the knowledge of the health officer. The health officer is usually too busy to worry himself with the detailed technicalities of the sanitarian's work. The sanitary engineers and sanitarians from the Central and Regional Offices are available for consultation in these matters with the local sanitarian. A relationship of confidence should exist between the local and state personnel, so that complications arising out of jealousy for authority may not develop. The squabbles that occur in the atmosphere of "who has authority in this or that matter", almost always arise out of someone's jealousy for power. Where a relationship of mutual confidence and collaboration exists, this complication almost never arises. The important consideration is getting the job done. The state personnel usually act in the capacity of technical advisors, whereas the health unit directors acts with administrative authority on local matters.

PERSONAL RELATIONSHIPS

The sanitarian should always be loyal to his work and his co-workers. This is a self-evident remark but because it is so obvious, it is sometimes overlooked. All workers are human beings and therefore have peculiarities. There may be a co-worker here and there who somehow rubs the wrong way. Such circumstances usually breed disunity, lack of cooperation, and as a result the work may suffer. This can easily be avoided if loyalty to one's work is uppermost as it should be. First of all one must learn to be frank inspite of one's sensitiveness, and thrash out difficulties in a level headed manner, and secondly, if this does not clear up the irritation, one can always ask for a transfer to another locality. Continued work with one not liked is apt to distort the workers opinion of that person and thus create false illusions about him or her. This may develop into a state of deliberate or unintended rumor spreading, and nothing is more unfortunate and disliked than such an eventuality. It is also unfortunate that now and then there comes one who hopes to gain advancement in position or compensation by deliberately carrying tales to a "higher up". No extensive comment is needed on the latter. In the long run, personal relationships with co-workers, if frank and full of consideration, breed a satisfaction and happiness--and no promotion can compensate for the lack of this feeling. On the other hand, such an esteemed relationship with one's fellow workers eventually leads to well earned respected and durable promotions. Tolerance of fellow workers in so far as is possible without sacrificing our efficiency should be a guiding principle.

THE POLITICAL SANITARIAN

An encouraging point that must be considered is that the political sanitarian in Louisiana has practically become a thing of the past. This is an important point in the sanitation program as well as other parts of the public health program because all are familiar with

the inefficiencies of a political manipulated organization and the political job holder. An efficient program of sanitation cannot depend on politics. The activity of the sanitarian brings him into contact frequently with the leading people and the governing bodies of the community; it offers an opportunity to participate in politics. At times it takes a considerable amount of courage to refrain from entering into the political situation. Public health work should be based on science not on partisan politics.

PROMPTNESS

Promptness in keeping appointments and in carrying on his work is a most valuable asset to the sanitarian. Few things annoy a busy person so much as to be kept waiting when an appointment has been made. If the sanitarian keeps his appointments promptly and is prompt in carrying on his work, the people that he deals with will soon learn and appreciate this fact and will respond to his efforts in a more satisfactory manner. They will realize that the work is being carried on in a sincere, business-like, and efficient way.

GOOD STANDING IN COMMUNITY

Now and then the health department gets into disrepute in a community because one of the personnel becomes careless in paying bills, or behaves in a manner unbecoming a public servant. This unfortunately has happened in the past. It is of utmost importance that public health personnel should be in good standing with the community. A teacher must set the example for the community, and every public health worker is a teacher. Debts should be paid promptly, drinking, if done, should be in private and without causing distasteful demonstrations to the public. In other words, conduct should be, as much as possible, exemplary.

THE SANITARIAN AS A TEACHER

The nurse and sanitarian contact more people than any other individual of a health department. The contacts are made usually under such circumstances that the event can in most cases be utilized as an opportunity to spread the health gospel. The efficient sanitarian never allows such an opportunity to pass. The education of the public is one of his most important functions. Every activity should be an educational opportunity. In order to be a teacher of sanitation, it is also necessary to have a good grasp of the general functions of a public health program. These general functions, considered in the modern sense are as follows: To carry on and develop the practice and theory of preventive medicine in all those fields where it may be practically possible. This includes the prevention of disease, prolongation of life and the promotion of physical and mental health and efficiency through organized community efforts directed toward: (1) The education of the individuals in the principles of personal and public hygiene. (2) The sanitation of the whole environment. (3) The control of all preventable diseases. (4) The organization of medical and nursing service for the early diagnosis and preventive treatment of disease. (5) The development of the social machinery which will ensure to every individual a standard of living adequate for the maintenance of health. (6) The intergration and organization of the above activities in such a fashion as will tend toward enabling every citizen to realize his birthright of health and longevity. (The above is from the definition of Public Health by C. E. A. Winslow).

The sanitarian must learn to utilize all methods of spreading the health gospel - short talks to schools and parents, help health officer write articles on sanitation for press, set up health displays, design posters, give out literature, show moving picture shorts and the like. The sanitarian should know how to organize a school for food-handlers. One of the most difficult tasks of the sanitarian is to obtain correct sanitary facilities and practices in food-handling establishments and maintaining these facilities and practices. One effective solution is to organize night classes for food-handlers, where once or twice each week a lecture and demonstration is given to interested food-handlers on how to become proficient in food sanitation. Every sanitarian should know how to operate a moving picture machine.

To be a good teacher, one must also be a good pupil. The sanitarian learns not only from his books and journals, but also from his practices in the field. More than a few times have the techniques found in the field practices of the non-trained layman proved to be better than those categorically accepted in books. The sanitarian must become one of the people of the community in order to wield influence. He must participate in the social life, belong to organizations. He must be sympathetic to the lot and aims of the majority of people and support those aims which will bring social betterment to the masses. It is a false conception that the sanitarian must follow the political line. The sanitarian is not and must not be a "politician", and must not prostitute his social judgment

to the aims of selfish men. Those organizations in the community which foster better living, higher wages, more education, healthier environment, should be supported by him, since basically because these things are the background of better public health. Thus, we must distinguish between being a politician in the derogatory sense, and being a student of and participant in the social and economic welfare of the community.

With the above background, the sanitarian should have no difficulty in approaching the public. No public would ever turn away from the leadership of such a person, since such a sanitarian soon becomes known as a friend of the people. He need not use the strong arm method of getting a job done; in fact, such a method is seldom necessary. A sanitarian who becomes known as a friend of the people will always be supported if now and then it becomes necessary to use the force of police power to accomplish an important end over the objections of an obstreperous individual. In most cases where corrections of techniques are necessary, the attitude of the sanitarian toward the operator of incorrect techniques should be that the latter was correct. But that newer knowledge has given us newer and better techniques, and since the operator was correct in the past, he should continue to be progressive and correct in the present and the future by accepting the new methods. To flatly tell a person that he has been wrong is poor psychology and seldom gets that person to accept a new practice.

SOCIOLOGICAL SCIENCES AS AN INSTRUMENT FOR UNDERSTANDING PEOPLE

The public health worker must understand why people or groups of people live and act in certain patterns, in order that he may be able to help correct the fundamental factors causing unsocial acts and attitudes and foster those factors which tend to product social well-being. He cannot accept the dictum that some people are born bad and others good; that some are poor because they are lazy and others rich because they are industrious; that the poor have weak mongrel blood and the well-to-do blue blood; that wars are inevitable because people instinctively like to fight; that the selfish instinct predominates over the instinct of mutual aid; that politics must be a racket; that dictatorship is a stronger form of government than democracy; that one race or religion is superior to another.

A good student of sociology, economics, political science, anthropology, genetics and other sciences can not sincerely accept such smug, narrow half-truths to explain the ills of society. The public health worker must look deeply into the social forces of society in order to gain truthful weapons in his fight for a better, healthier society. Take only one example. The poor, Louisiana farmer, tenant, or sharecropper is blindly branded as a lazy good-for-nothing. From all appearances, he certainly looks just that. But that the poor French speaking farmer in South Louisiana is descended from sturdy French-Canadian stock and that the poor farmer in the Northern part of Louisiana came from the stout, hardy, frontiersmen of the Southeastern United States some years back when the young country was bursting with growth and vigor is a fact. These people came with moderate or scanty means to settle the state, but many brought with them the sturdy richness of the pioneering spirit which made us such a great country. "Moderate means" could even then buy only the less fertile, sandy, hilly, pine country. The well-to-do could buy the fabulously fertile alluvial soil which produce four to six times as much cotton per acre than the pine country soil. These differences caused one group to become or remain rich and another poor. Generation after generation the poor became poorer and the rich richer largely because of the social and economic problems relating to the land. Can one expect to find a finely sensitive morale in a farmer, who has worked the soil for years, has had a scanty education, has reared a house full of children and finds himself year after year more pauperized than ever? Can one expect virile citizens of his children whose bodies have become degenerated by poor nutrition, whose vitality has become sapped by hookworm, malaria and other diseases, and whose minds have become warped by the insecurity and hazard of living? And what can be expected of the children of these children?

Breadth of vision will show the historical development, the causes of existing conditions in their real sequence and will not be blinded by shallow appearances. If public health workers put first things first, then their public health acumen will grow rich and their service fruitful.

PROJECT PLANNING, COSTS, AND FINANCING

Because the sanitarian's work is involved in the sanitary housing of food producing and dispensing establishments, he must become acquainted with techniques of construction, estimating costs, and methods of financing. He must know the details of how to construct privies, septic tanks, wells, springs, cisterns, dairy buildings, slaughter houses and the like. The details of construction of sewerage systems, water systems, abbatoirs and

the like are the job of the sanitary engineer. But the sanitarian should be acquainted with such larger forms of construction although he depends on the engineer for the last word.

A sanitarian should be able to make a survey of a parish and estimate the number of privies that would be necessary to be built in order to sanitate the area. He should know approximately how many of the needed privies could be constructed considering the economics of the area, how much the material would cost per privy, how well such a project would be accepted in the community, how to interest the community in such a project, how to obtain such a project through the W.P.A.,how to obtain construction of privies among those who are unable to finance the cost. If the financing of a project is to be handled by the town or parish, he should have a clear idea how the financing is to be accomplished, whether by: (1) Bond Issue (long term notes), (2) Certificate of Indebtedness (short term notes), (3) Notes. He should be acquainted with the techniques for repayment of the debt, i.e., (1) Sinking Fund Technique, (2) Serial Payment Technique,(3) Pay-as-you-go System.

He should know what source the funds should come from, whether from: (1) General Tax on Property, (2) Special Assessment Technique, i.e., tax on special aspects of property such as frontage or area, (3) Service to Property.

He should know how and on what basis the Federal Government helps to finance public health projects.

He should know what his community can afford to spend and consequently the feasibility of a particular type or project.

His acquaintance with the above information will give him imagination for stimulating the development of such projects as, well drilling, septic tank construction, rat control, mosquito control, refuse disposal, water supply system, sewerage system, etc.

If projects are developed through the W.P.A. he should know that the technical supervision is strictly the function of the Health Department; that the W.P.A. foreman or supervisor is a representative of the Federal Government and is directly responsible for the efficient operation of the work, the maintenance of all safety standards and the preparation of all job reports and records required under W.P.A. procedure; that the selection of sites and the procuring of material to be used in the project is the responsibility of the sponsoring agency (the parish, town or health department); that all plans and specifications must be approved by the health department; that transportation of W.P.A. workers, materials and supplies are strictly a function of the sponsoring agency and in all cases should be effected without cost to the workers; that W.P.A. workers should not be used to demolish buildings for the purpose of salvaging material; that W.P.A. workers should not be used for maintenance work; that these workers should not contribute any of their work for construction of sanitary facilities for new buildings unless the buildings themselves are part of the W.P.A. project.

RECORD KEEPING

The sanitarian must never forget that he must keep good records. Without records it is difficult to evaluate systematically the work that has been done, is being done, and should be done; how many sanitarians are required to carry on the work of a parish under one or another set of conditions; why one parish should accomplish more than another; and many things of like nature. The sanitarian without records can never justify his merits for advancement either in pay or position. Each state health department has its method of recording activity. The sanitarian must study and learn the significance of each record and even suggest improvement of same if he sees fit to do so.

Record keeping is a job least liked by any field worker. Yet, if an appropriating body asked for a record of sanitary accomplishments over a certain period of time in order to consider whether it is justified in making appropriations for the health unit, the criterion for getting the funds will depend not so much on what has actually been done, but on how well records were kept on what has been done. A health officer cannot go empty handed to an appropriating body to get his funds increased. Records reflect past works and justify future expenditures.

SCOPE OF ENVIRONMENTAL SANITATION PROGRAM

The personnel who work in the field of environmental sanitation can be separated into two large groups, the sanitary engineers and the sanitarians. The work of the two overlap here and there, but generally, the engineer is devoted to the technical planning,

supervision, and administration of sanitary work, and the sanitarian is the skilled field worker who carries on the less technical duties associated with inspection and maintenance of sanitary facilities and techniques not involving detailed engineering knowledge. In order for the sanitarian to grasp the extent of functions involved in environmental sanitation, the following outline is presented. This outline does not distinguish between the functions of the engineer and the sanitarian but portrays what the whole field of environmental sanitation includes. The sanitarian, through his experience and training, will learn which duties are in his realm and which belong to the sanitary engineer.

A. PUBLIC WATER SUPPLIES
  1. Municipal - (a) Makes routine surveys of existing water works and recommends improvements to local officials. (b) Reviews and approves plans for new plants and extensions or improvement of existing plants. (c) Makes special investigations upon request. (d) Advises local superintendents on operation, laboratory procedure, etc. (e) Checks operation efficiency of treatment plants. (f) Collects specimens and interprets reports of analysis made by State Laboratory. (g) Makes well location surveys. (h) Reviews operation reports submitted by operators. (i) Holds regional conferences for operators and superintendents.
  2. Makes inspections and certifies to United States Public Health Service all drinking water used on common carriers.
  3. Rural - (a) Devises plans for adequate well, spring, and cistern construction.(b) Inspects existing facilities and recommends corrections where needed. (c) Supervises building of new facilities or reconstructing old ones. (d) Takes water samples where indicated. (e) Organizes projects for obtaining adequate water supplies for rural schools and homes.

B. PUBLIC SEWERAGE, SEWAGE DISPOSAL
  1. Municipal - (a) Reviews and approves all plans for new sewer systems and sewage disposal works, and for extensions to same. (b) Makes routine inspections of sewage treatment plants, and recommends improvements to local officials. (c) Makes special field investigations to : 1-Check efficiency of plant. 2-Advise operator on plant operation and plant laboratory procedure. (d) Organizes projects for obtaining adequate excreta disposal facilities for rural schools and homes.

C. MUNICIPAL WASTE DISPOSAL
  1. Makes investigations and gives advice to local officials on garbage and refuse disposal.

D. STREAM POLLUTION
  1. Makes investigations of stream pollution including: (a) Bacteriological and chemical examinations of stream water to determine extent of pollution. (b) Determination of s[illegible]ce of pollution, and chemical examination of sewage and industrial waste. (c) Exam[illegible]nation of the physical condition of streams.
  2. Prepares reports covering stream pollution investigation.
  3. Assists in conduct of hearing on stream pollution.

E. SWIMMING POOLS
  1. Reviews and approves plans and specifications for new pools.
  2. Makes inspections and advises managers and operators through reports and bulletins.
  3. Interprets results of analyses.
  4. Reviews weekly operation reports.

F. ICE PLANTS
  1. Makes routine inspections of water supply, cross connections, brine tanks, ice storage rooms, food storage, toilets, and other sanitary facilities.

G. STATE INSTITUTIONS
  1. Makes routine inspections of water supply, sewerage, garbage disposal, and milk sanitation, and reports findings.
  2. Reviews and approves plans and specifications for sanitary facilities.

H. STATE AND FEDERAL PARKS
  1. Reviews plans and specifications for all sanitary facilities.
  2. Makes inspections of water supply, sewerage, garbage disposal and swimming beaches.

I. COMMUNICABLE DISEASES
  1. Cooperates with epidemiologist by making the necessary sanitary investigation such as water, milk, insects and rodents, and plumbing, in the conduct of an epidemiological study.
  2. Supervises emergency, installations of water purification devices, etc., in case

of epidemic or threat of epidemic.

J. PLUMBING

1. Prepares, revises and interprets state plumbing code.
2. Acts in advisory capacity to local enforcement agencies.
3. Makes plumbing inspections on all new or repaired installations.

K. PUBLIC HEALTH NUISANCES

1. Makes investigations on request, and advises as to corrections.

L. SUMMER AND OTHER CAMPS

1. Makes inspections of sanitary facilities including water supply, sewerage,sewage disposal, refuse disposal, swimming pools, milk, housing and foodhandling, and advises directors and operators on general sanitation matters and suggests improvements.

M. MILK SANITATION

1. Makes fact-finding surveys on condition of milk sanitation.
2. Assists in drawing up ordinance and in setting up local inspection service.
3. Makes inspections and grades dairies or plants according to ordinances.
4. Serves as technical advisor for all milk sanitation problems.
5. Holds schools for instructing dairymen and milk plant operators.
6. Collects samples, sends them to laboratory and makes interpretations.

N. MALARIA CONTROL, MOSQUITO AND OTHER INSECT CONTROL

1. Makes surveys to determine the nature and extent of problems.
2. Estimates cost of projects and recommends methods in line with local finances.
3. Organizes program for control.
4. Supervises the carrying out of the project, supplying the technical assistance necessary for drainage, spraying, screening or naturalistic methods of control.

O. INDUSTRIAL HYGIENE

1. Conducts preliminary survey of all types of industry to determine nature and magnitude of hazards caused by dusts, gasses, vapors, improper ventilation, poor lighting, etc.
2. Makes studies of hazardous processes and conditions, advising industries of findings and recommending methods of control.
3. Reviews occupational disease reports and investigates cases reported.
4. Promotes keeping of sickness records by industry and associated organizations and makes statistical analyses of such reports.
5. Acts in advisory capacity to enforcement agencies.
6. Conducts educational program to acquaint industry, labor and other interested groups with importance of program.

P. FOOD SANITATION

1. Devises techniques for sanitary handling and preparing of foods.
2. Inspects all manufacturers, transporters, and vendors of food for - (a) Adequate sanitary techniques and facilities (b) Health of food handlers (c) Registration of products and dispensation of permits for operation.
3. Cooperates in handling legal matters where violations have been committed.
4. Holds night schools sessions for food handlers, teaching them correct techniques and thus enlisting their cooperation through education.
5. Collects samples, sending them to laboratory and interpreting the results.

Q. MEAT SANITATION

1. Examines all animals before slaughtering.
2. Examines all animals after slaughtering.
3. Draws up plans for sanitary slaughter houses and abbatoirs.
4. Devises sanitary techniques for handling meat.
5. Inspects regularly all slaughter houses and abbatoirs and techniques used.
6. Sees that meat-handlers are healthy.

R. SEAFOOD SANITATION

1. Devises sanitary methods of transporting, packing and processing.
2. Sees that handlers are healthy.
3. Inspects all techniques and quality of food.
4. Inspects the physical condition of plants.

S. RABIES CONTROL

1. Cooperates with health officer in devising a plan and technique for controlling

rabid dogs and preventing well ones from getting sick. - (a) Vaccination program (b) Dog-catching program (c) Quarantine of new-comers (dogs) to locality.

T. RODENT CONTROL
1. Surveys extent and nature of problem.
2. Determines the most effective and economical way of control.
3. Gives technical supervision in rat proofing, vent stoppage, poisoning, etc.

U. SCHOOL SANITATION
1. Acts in advisory capacity to department of public education on water supply, sewage disposal, heating, lighting, and ventilation.
2. Prepares and distributes bulletins and standard plans on sanitary facilities.

V. RURAL AND COMMUNITY SANITATION
1. Sponsors and supervises W.P.A. privy programs.
2. Prepares and distributes standard plans on private water supplies and private sewage disposals.

W. HOUSING, LIGHTING, VENTILATION AND HEATING
1. Health Department jurisdiction in these matters extends only to public buildings and places of business, but may serve in advisory capacity to federal housing projects or any private housing project upon request.

X. HIGHWAY SAFETY
1. Cooperates with highway department in planning hazard elimination by consideration of: (a) Width of road (b) Grade of incline and curve (c) Crossings (d) Closeness to schools, playgrounds, thickly populated areas, etc. (e) Control of speed (f) Competency of driver.

Y. COOPERATIVE WORK WITH OTHER STATE AND FEDERAL AGENCIES
1. Reviews plans and specifications of all sanitary projects financed with federal aid.
2. Makes inspections and acts in advisory capacity on matters of sanitation to state and federal agencies, including Farm Security Administration, Federal Housing Administration, Department of Social Welfare and Civilian Conservation Corps.

SCOPE OF PUBLIC HEALTH PROGRAM

The scope of the entire public health program as it is generally practiced today can be gathered from the following skeleton outline:

A. COMMUNICABLE DISEASE CONTROL
1. Field visits to investigate diseases and instruct families in techniques of preventing spread; consultation with physicians; immunization against smallpox, diphtheria, typhoid fever and whooping cough.

B. TUBERCULOSIS CONTROL
1. X-ray of contacts and suspicious cases.
2. Home nursing hygiene service.
3. Contact follow-up.
4. Burr cottage service.
5. Financial aid for transportation, clinic facilities, Burr cottages, etc. by local tuberculosis association .

C. VENEREAL DISEASE CONTROL
1. Clinic service.
2. Follow-up service.

D. MATERNITY HYGIENE
1. Home nursing hygiene service.
2. Medical clinic service.
3. Home delivery service.
4. Maternity bundles, etc. thru health committee.
5. Midwife supervision.

E. INFANT AND PRESCHOOL HYGIENE
1. Medical conferences.
2. Nursing conferences and home hygiene service.
3. Lay committees for obtaining corrections of defects.
4. Immunizations.

F. SCHOOL HYGIENE
1. Physical examinations.
2. Lay committees for obtaining corrections of defects.
3. Supervision of school lunch rooms.
4. School sanitation.
5. Immunizations.

G. CRIPPLED CHILDREN SERVICE
1. Finding crippled children, directing them to clinics for diagnosis and treatment. Hospitalization service; rehabilitation of each child.

H. ADULT HYGIENE
1. General clinic for examination and advice.

I. NUTRITION
1. Surveys to point up deficiencies and recognize good practices.
2. Program during prenatal care.
3. Infant feeding.
4. Program for preschool child.
5. Teaching nutrition and serving school lunches to school children.
6. Education of adult and professional groups.
7. Preparation of literature.

J. LABORATORY SERVICE
1. Blood, urine, feces, sputum, spinal fluid examinations.
2. Water examinations.
3. Milk examinations.
4. Sewage examinations.
5. X-ray service.

K. SANITATION
Already considered above

L. HEALTH EDUCATION
1. Newspaper articles.
2. Talks to schools and lay groups.
3. Moving pictures.
4. Literature.
5. Participation in health project.

M. STATISTICS COMPILATION
1. Registration of births, deaths, and diseases; tabulation of these and analysis and interpretation of same.

N. HEALTH COMMITTEES
1. Active P.T.A.
2. Active Tuberculosis Association.
3. Active Crippled Children's Society.
4. Active Business Men's Club
(All these are combined into one general health committee)

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Principles of Bacteriology

Because bacteria are unicellular vegetable organisms which grow, reproduce, breath, take in food, give off waste, and respond to stimuli, those fundamental principles which pertain to any living matter apply to bacteriology, that branch of science which has to do with study of bacteria.

Bacteria (Schizomycetes) are not the only unicellular plant organisms, although they are, so far as present knowledge goes, the most important plant microorganisms associated with human diseases. Another group of unicellular plant microorganisms is the yeasts (Blastomycetes). These, together with the molds (Hyphomycetes) are also important in consideration of disease. The molds include both unicellular and multicellular plant organisms. The algae, which are marine unicellular and multicellular plants, and the diatoms, which are marine unicellular and colonial plants are of less importance to the problem of human disease than the foregoing.

The most fundamental set of forces which determine the character of living things are ENVIRONMENT and HEREDITY. No organism can be studied and understood without knowledge of these two forces. The better one understands these factors, the greater the increase of understanding of living material. But since these factors are fundamentally inseparable, the study of one must be in terms of the other, i.e., heredity can be studied only be observing the effect of environment upon it. The effect of the environment upon the heredity can be observed only by noting the degree of change in the constitution and reactability of the organism. The changes in constitution and reactability (form and function) of a bacterium may be temporary or permanent. Example, the typhoid fever germ usually fails to ferment dulcitol, but when grown on a medium containing that alcohol, it gives colonies which develop dulcitol-fermenting groups (Penfold 1910-11); while the paratyphoid fever germ "B" behaves similarly toward raffinose. If the modified germs are grown on these media over a long period of time, the successive generations have less and less tendency to revert to the original type. It is also known that bacteria of the coli-typhoid-dysentery group may change from relatively virulent types to relatively non-virulent types by changing the media in which they grow from solid (agar) media to fluid (broth or peptone water) media. With such changes there usually also appears change in the structure of the organisms.

Ordinarily, unicellular organisms are considered sexless, because in most instances they reproduce by dividing in two or by developing buds which break off from the mother cell. There appears to be no union of opposite sex elements in the process of reproduction. But this is only apparent because in reality, each cell contains within itself both sex forces. This continuous state of union and, hence, continuous reproduction explains why one-cell organisms reproduce so rapidly.

The hereditary characteristics of a living organism are carried on through generations by the sex elements. Any change in the sex element results in a change of constitution or reactability of the next generation. Whether it be the internal environment of the cell or its external environment which causes it to be modified, does not alter the fact that a hereditary change is accompanied by an environmental change, and an environmental change by a hereditary in constitution and reactability. The degree of permanence or impermanence of the modification of the constitution and reactability of the organism depends upon the permanence or impermanence in the change of the environment and the heredity.

The age of the organism also effects its constitution and reactability. But the age is merely an expression of the length of time the cell has been undergoing its development in its ever changing external and internal environment. The fact remains that all living material is in a continual process of change, be the living material a microbe or a human being.

ENVIRONMENT

The environmental factors which affect the growth and development of bacteria are: (1) The degree of moisture of the surroundings. (2) The degree of temperature of the surroundings. (3) The degree of acidity or alkalinity (pH) of the medium. (4) The type of electrolytes in the medium. (5) The osmotic pressure of the medium. (6) The degree of oxygen (O_2) tension of the surroundings. (7) The degree of Carbon Dioxide (CO_2) tension of the surroundings. (8) The degree of other gas tension of the surroundings. (9) The character of the nutritive material in the medium (vitamins, minerals, etc.). (10) The amount of exposure to various degrees of light. (11) The enzymes present in the medium.

(1) MOISTURE: Water is necessary for the growth and development of all living matter. Pure water is a poor medium for growth and development because it contains none of the nutritive elements, such as vitamins, sugars, proteins, and none of the chemical elements such as acids and bases, and lacks many physical properties such as proper osmotic pressure, oxygen and carbon dioxide tension. Usually, bacteria die in a dry environment. A few bacteria such as anthrax and tetanus bacilli, which have the ability to form spores, may remain viable for years. Other non-spore forming bacteria may be kept alive by drying over an extended period of time. This depends on the medium in which they are dried, the rapidity of drying and other environmental factors. But viable dry bacteria neither grow nor reproduce; they hibernate so to speak. Less moist solid media may cause bacteria to change their structure and reactability as compared with the character of their structure and reactability when grown on liquid media. (Drying food to preserve is the most common practical application).

(2) TEMPERATURE: The life processes of bacteria are very sensative to temperature. The bacteria which usually invade or live upon or within the human host have in most instances an optimum temperature for best growth and development which is close to that of the human body. Other bacteria which live on vegetable matter and are found in or upon the ground have an optimum temperature for best growth and development which approaches that of the ground or the atmosphere. Thus, for most pathogenic bacteria, the optimal temperature for growth is in the neighborhood of 37°C and the range of temperature over which growth occurs is approximately 15-40°C. There are also many varieties of non-pathogenic organisms which have a similar temperature range for growth. There are some bacteria which will grow at 0°C, while others known as thermophiles which have optimum temperatures of growth around 55°C and may grow in temperatures as high as 75°C. Many of these latter types are found in milk which has been contaminated by soil excreta, silos, and the like. The human and bovine tubercle bacilli grow best at 37°C and fail to grow below 30°C; the avian type of tubercle bacilli grow best at 40°C and fail to grow below 30°C, while the cold blooded type such as found in fishes grow freely at 22°C. Heat processing and freezing are commercial applications to food preservation.

Dry heat is not as good a means of destroying bacteria as moist heat. A temperature of just over 100°C for $1\frac{1}{2}$ hours destroys all vegetative bacteria and 140°C for 3 hours destroys all spores in dry heat; but a temperature of only 105°C for 10 minutes destroys even the spores in moist heat. The greater the pressure under which the heat acts, the quicker the destruction of the bacteria. For this reason, steam under pressure is the principle used in the autoclave for sterilization.

(3) ACIDITY AND ALKALINITY OR pH: The pH represents the degree of acidity or alkalinity of a medium. When acids or alkalies are dissolved in water, they dissociate into atoms or/and groups of atoms which carry negative and positive electrical charges. These are called ions. Example: $HCL \rightleftarrows H^+ + CL^-$, which means that hydrochloric acid in solution dissociates into hydrogen ions with positive electrical charges and chlorine ions with negative electrical charges. Another example: $NaOH \rightleftarrows Na^+ + OH^-$, which means that sodium hydroxide dissociates into positively charged sodium ions and negatively charged hydroxyl ions. The characteristic of an acid, then, is that when dissociated, it yields positively charged hydrogen ions and these hydrogen ions determine the fact that it is an acid. The characteristic of a base is that dissociated, it yields negatively charged hydroxyl (OH) ions, and these hydroxyl ions determine the fact that it is an alkali. The degree of dissociation of an acid or alkali may be greater as in the stronger acids or may be less, as in the weaker acids or alkalies. The hydrogen-ion or hydroxyl-ion concentration depends upon the degree of dissociation of the acid (H^+) or alkali (OH^-) respectively, and equal quantities of different acids or alkalies will be weaker or stronger, depending upon their inherent ability to dissociate into more or less ions. For example, if equal quantities of hydrochloric acid, acetic acid, and boracic acid are put into solution, the hydrochloric acid will be the strongest acid, acetic acid will be next, and then boracic acid, because hydrochloric acid dissociates into ions more than the other two acids, while boracic acid dissociates least. The same facility for ionization determines strong and weak alkalies.

Thus, acidity is determined by the presence of free hydrogen ions (H^+) and alkalinity by the presence of free hydroxyl ions (OH^-) in a given volume. A solution is truly neutral when it contains an equal number of hydrogen and hydroxyl ions. Pure distilled water is neutral, and analyses have shown that at 22°C it contains approximately 0.0000001 gram of hydrogen ions in a liter. This may be written 10^{-7} or $\frac{1}{10^7}$ gram hydrogen ions per liter. A normal solution of hydrogen is one which contains 1 gram hydrogen ions in 1 liter. Hence, a neutral solution is one which is 10^{-7} normal. Inasmuch as a neutral solution contains equal numbers of hydrogen and hydroxyl ions, it must also contain 10^{-7} equivalents of hydroxyl ions. The chemist has discovered

that the normality of the hydrogen ion concentration times the normality of the hydroxyl ion of any solution is equal to a constant approximately equal to 10^{-14}. Therefore, if the hydrogen or hydroxyl concentration of any substance be known, the unknown can readily be calculated. Thus, if the hydrogen ion concentration of a solution be 10^{-4}, the hydroxyl concentration would be 10^{-10}. Using this information we may make the following scale to indicate the acidity of solutions:

$$10^{0},\ 10^{-1},\ 10^{-2},\ 10^{-3},\ 10^{-4},\ 10^{-5},\ 10^{-6},\ 10^{-7},$$
$$10^{-8},\ 10^{-9},\ 10^{-10},\ 10^{-11},\ 10^{-12},\ 10^{-13},\ 10^{-14}.$$

That is, the larger the numerical value of the exponent the smaller the hydrogen ion concentration and the greater the hydroxyl ion concentration. Example: 10^{-1} is greater than 10^{-7}, because 10^{-1} is equal to $\frac{1}{10^{1}}$ or 0.1, where as 10^{-7} is equal to $\frac{1}{10^{7}}$ or 0.0000001.

Such numbers are somewhat cumbersome, hence Sorensen suggested that only the exponent be used, and this be expressed as a positive instead of negative number. Thus he designated the pH, or Hydrogen potential, of the solution. Written in terms of the pH values, the scale becomes:

$$\xleftarrow{\text{Greater Acidity}}$$

Acidity . . . . 0, 1, 2, 3, 4, 5, 6.

Neutrality . . . . __________ 7 __________

Alkalinity 8, 9, 10, 11, 12, 13, 14

$$\xrightarrow[\text{Greater Alkalinity}]{}$$

All values above the neutrality line indicate acid solution and the smaller the number the greater the acidity. All numbers below the neutrality line indicate alkaline solution; the larger the number the greater the alkalinity.

It is clear then, that a pH or 7.0 is the neutral point between acidity and alkalinity. Anything above 7.0 is in the alkaline phase, and anything below 7.0 is in the acid phase. For any given species of bacterium there is an optimal and relatively narrow range of pH allowing vigorous growth. For most of the bacteria associated with the bacteriology related to the human being, the optimum pH is a little to the alkaline side of neutrality (pH 7.2 - 7.6). The range over which growth is possible for most pathogenic bacteria is probably between pH 5.0 and pH 8.0. The various groups of B hemolytic streptococci can be differentiated by measuring their pH range.

Pickling (low pH) is commercial application in food preservation.

(4) ELECTROLYTE: An electrolyte is a compound which dissociates in water into positive and negative electrically charged parts, which parts migrate to the oppositely charged poles or electrodes when an electric current is passed thru the solution. Since all living material is electrically charged and since the fundamental processes of metabolism are electrical in nature, it is evident that the compounds in the living matter which carry the electric charges are of fundamental importance to the growth and development of organisms. Hence, various salts in varying quantities are of importance for the growth of species of bacteria. Some of the salts are favorable for growth in one medium and the same salt in another medium may be toxic. Certain concentrations of NaCl (table salt) may cause rapid death to meningococcus organism, but when a calcium salt is added the lethal effect is neuralized. It can be seen from this that the interchange of the electrically charged particles (elements of electrolytes) play a decisive role in the life process of bacteria.

OSMOTIC PRESSURE: Osmosis is the selective flow of certain components of a solution through a semi-permiable membrane. The direction and the amount of flow through the membrance depends not only on the size of the molecules on either side of the membrane, but on the nature of the solute, the solvent, and the membrane itself. Other factors not considered, more molecules will pass from the side with greater numbers per c.c. (smaller sized molecules) to the side with less numbers per c.c. (larger sized molecules). When the flow is over, there will be a difference of pressure between the two sides of the membrane. This difference of pressure is called the osmotic pressure.

All bacteria have membranous coverings. But it is extremely doubtful whether salts, except perhaps in very high concentrations, exert any influence on bacteria by virtue of their osmotic pressure. Bacteria differ from practically all other living cells in

being profoundly indifferent to changes in osmotic pressure. Although salts have no direct action of this nature on bacteria, they may exert an indirect action by causing a deydration (loss of water) of the proteins on which the organisms are growing. It is this dehydrating action of salts which is relied on in many processes of food preservation. Curing meat by salt is ancient application of this principle.

OXYGEN TENSION: Among the most important of the gaseous requirements of bacteria is the preference shown by many species for particular ranges of oxygen (O_2) pressure, and the inability of certain species to multiply in the presence of this gas. On this basis it is customary to divide bacteria into three categories: (1) Those which will grow only when molecular oxygen is rigorously excluded or obligatory anaerobes. (2) Those which will grow both when molecular oxygen is present or absent or facultative anaerobes. (3) Those which will grow only when supplied with molecular oxygen or obligatory aerobes.

Most bacteria belong to the second group and are able to grow over very wide ranges of oxygen pressures, but some species prefer a relatively restricted range, lying well below that of ordinary atmospheric conditions. The facultative anaerobes are by no means indifferent to variations in oxygen pressure. When deprived of oxygen they do not lose the capacity for growth, but their metabolic mechanisms change, with a consequent change in their nutritional requirements. In reality, this second group requires oxygen at all times for growth, but unlike the third, it can utilize oxygen from compound substances such as nitrates as well as molecular oxygen, whereas the third group can only utilize molecular oxygen.

CARBON DIOXIDE (CO_2) TENSION: There are many observations indicating that carbon dioxide is necessary for the growth of several, perhaps all species of bacteria including anaerobes. Lack of CO_2 will often, but not always prevent the multiplication of some bacteria, the most common of which are the colon, typhoid fever, anthrax, diphtheria, gas-gangrene organisms. Packaging food in inert atmospheres of nitrogen is practiced to retard bacterial growth.

NUTRITION: Perhaps the most striking feature of the nutritional activities of bacteria is their extreme diversity. Unlike most plants and all animals, the nutritional mechanisms of the various bacteria have no common pattern. It is clear that they have been evolved by selective adaptation to the widest variety of environmental conditions, so that one species or another can take advantage of almost any possible type of food-stuff, and any biologically adequate environment. This ubiquitous colonization by bacteria as a class has been made possible only by a correspondingly wide differentiation in their metabolic activities, so that the nutritional needs of each bacterial group or species becomes a law to itself. Most bacteria can build up their carbohydrates, fats, and proteins from simple inorganic or organic substances. Trytophane is the only amino acid which is essential to some bacteria. Some bacteria can synthesize their own tryptophane. There are indications that bacteria require certain vitamins for their growth.

LIGHT: A very small group of bacteria have a photosynthetic type of metabolism, but most bacteria do not employ this mechanism. Photosynthesis is the process by which the green stuff (chlorophyll) of plants manufactures carbohydrates thru the action of the sunlight.

To most bacteria the ultra-violet rays of the sun or artificial light is lethal. Ultra-violet rays kill not only bacteria but almost all unicellular organisms including tissue cells of animals and plants; it is a photoplasmic poison. Since ultra-violet rays have a very poor penetrating power their action is mostly limited to the surface of an organism. These rays have not only a destructive effect on living cells but also on cell products such as protein. This action on protein by light explains another reason for the lethal effect of light on bacteria, since the light may alter the nutritive media in which bacteria grow in such a way as to make the media poisonous to the bacteria. The length of time and the amount of light acting on bacteria or its media determine the degree of its lethal effect. Sun drying of food is an ancient practice.

ENZYMES: An enzyme is an organic catalytic agent, i.e., it is secreted by living cells and has the power of inducing chemical changes in organic matter without apparently being changed itself. Yet there is some indication that certain enzymes may be changed while inducing changes in other substances.

Enzymes are of fundamental importance in the metabolism of bacteria as well as all living material. Metabolism concerns itself with a two-fold process of synthesizing material and breaking down material for energy uses. Enzymes play a very important role both in the breaking down processes (catabolism) and the building up processes (anabolism) of organic matter. Quick pre-heating before commercial quick-freezing is practiced to inactivate the enzymes.

The reason that some bacteria are able to grow in the presence of free molecular oxygen and also combined oxygen in compounds is due to the fact, that these bacteria are able to change their enzyme systems to suit their environment.

The methylene blue test for determining the bacterial contamination of milk is possible because the methylene blue dye is sensitive to the enzymes produced by the bacteria in the milk. The more bacteria in the milk the more bacterial enzymes and the sensitive blue dye is changed to a colorless substance in a correspondingly quicker time.

The test for adequate pasteurization of milk is also dependent upon measuring the presence of an enzyme. In this case the enzyme is one which is natural in raw cow's milk. This enzyme (phosphatase) is very sensitive to high temperature and will be devitalized at $143\frac{1}{2}$°F for 30 minutes. It is indeed a remarkable observation that the test is sensitive enough to show that lack of pasteurization if milk is held at 143°F for 25 minutes, $141\frac{1}{2}$°F for 30 minutes, or if as little as 1/10 of 1% of raw milk is added to pasteurized milk.

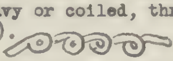
The oxidation-reduction system of reactions in chemistry is one of its most fundamental processes. (Oxidation is the removal of electrons from radicals and reduction is the adding of electrons to radicals). This is a complementary system of processes. Where one process is present, the other also exists. This complementary system is also found in the chemistry of organic material. The enzymes are substances which aid in initiating and carrying on these processes in living organisms. Bacteria as well as other living things have enzymes for digesting proteins, fats, carbohydrates and other organic substances. The action of enzymes demandsoptimum conditions of temperature, pH, electrolytes and other variables for most vigorous functioning.

The above discussion of environmental factors affecting the growth and development of bacteria gives an idea of the complicated system of conditions which affect the life of these apparently simple organisms; yet, the above discussion is elementary and far from complete. A detailed survey of the environmental factors affecting bacterial growth and development would be intricate and lengthy and would compare in complexity with a study of environmental factors of higher forms of living organisms.

CONSTITUTION (Morphology)
The interaction of environment and heredity as before mentioned result in the particular constitution and reactability of the bacteria. The usual constitutional characterisitcs used in identifying bacteria are: 1. Size 2. Shape 3. Internal structure 4. Cell membrane 5. Cell capsule 6. Appendages.

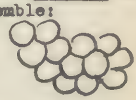
(1) Not considering the few very large bacteria and the group of very small organisms, the average size would be about 1/10 to 5 one thousandths of a millimeter. Variability in size of the same species of bacteria is very common and is rather the rule than the exception. The variability in size of course is due to the complicated internal mechanism of reproduction and to the influence by the environment on the reproductive, growth and developmental processes.

(2) Variability of shape is as universal among bacteria as variability of size. Some show little such variability, while for others such changes of shape are characteristic. We recognize five main types of bacteria cell forms:

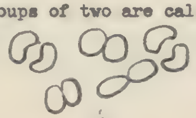
1. Spheroidal or coccal (meaning berry-like) 
2. Cylindrical or bacillary (meaning rod-like) 
3. Rigid, curved or spiral-spirillum (meaning coil) 
4. Filamentous (thread or chains of rods) 
5. Flexible, wavy or coiled, thread-like - spirochetal (meaning coiled hair). 

Most bacteria derive their basic descriptive name from the above five classifications. The following 12 groups make up the most common forms of bacteria.

(a) Coccal bacteria assembled in groups like grapes are called staphylococci (Staphyl meaning bunch of grapes - Coccus meaning berry). Diagrammatically they resemble:
In this group are found the bacteria which may cause food poisoning (Staph, aureus), boils and carbuncles (Staph. aureus, Staph.albus, Staph. citreus).



(b) Coccal bacteria assembled in groups of two are called diplococci (Diplo meaning double) Diagrammatically they resemble:

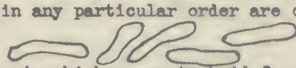


In this group are found the bacteria which cause Meningitis (Neisseria Meningitidis), Pneumonia (Diplococcus Pneumoniae), Gonorrhea (N. Gonorrhae).

(c) Coccal bacteria assembled in chains are called streptococci (Strepto meaning curved) Diagrammatically they resemble: 

(d) Sarcina (meaning bundle) bacteria are so named because they are assembled in bundles. Diagrammatically they resemble:  Practically all of these are not disease producing in man.

(e) Bacillary bacteria not arranged in any particular order are called bacilli (meaning rods) Diagrammatically they resemble:



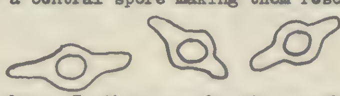
In this group are found the bacteria which cause typhoid fever (Bacillus typhosum),dysentery (various types of B. dysenteriae), food poisoning (B. Paratyphosum A,B, or C), Tuberculosis (Myco bacterium tuberculosis), diphtheria (coryne bacterium diphtheriae).

(f) Bacillary bacteria arranged end to end in pairs are called diplo-bacilli (diplo meaning double and bacillus meaning rod).
Diagrammatically they resemble:

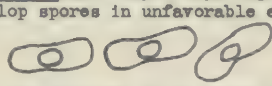
Practically all of these are not disease producing in man, but sometimes variations of pathogenic bacilli may resemble this group.

(g) Bacillary bacteria arranged end to end in larger numbers than pairs, to form filaments are called streptobacilli (meaning chains of rods). These are usually classified as belonging to the group called actinomyces (the filamentous-like group of bacteria). Diagrammatically streptobacilli resemble:

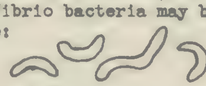
(h) This group is made up of spore-bearing anaerobes (grow and develop in the absence of molecular oxygen. It includes a number of disease producing germs such as the ones which cause tetanus (Cl. tetani),gas gangrene (Cl. Welchii, Cl. oedmatiens, Cl.septique), food poisoning (Cl. botulinum). Clostridium (meaning spindle) bacteria are so named because they have a central spore making them resemble a spindle. Diagrammatically they resemble:



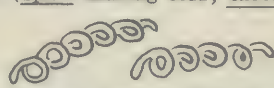
(i) Spore-bearing aerobes. In the spore-bearing aerobic group are found the bacteria which produce anthrax (B. anthracis)and many non-pathogens whose habitat is the ground. These are bacteria which develop spores in unfavorable environment. Diagrammatically they resemble:



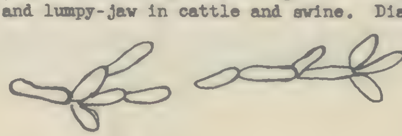
(j) In this group are found the bacteria which cause cholera (Vibrio cholerae). One of the spirilla has been found pathogenic for man or animals, that is, the one causing rat-bite fever (Sp. minus). Spirilla and Vibrio bacteria may be either comma or spiral shape. Diagrammatically they resemble:



(k) This group is not always classified as bacteria because the organisms have motility without possessing flagella. In this group are found germs which cause syphilis (Trep. pallidum),jaundice (Lepto. Icterohaemorrhagiae), yaws (Trep. pertenue),relapsing fever (Trep. recurrentis). Spirochetes (spiro meaning coil, chete meaning flowing hair). Diagrammatically they resemble:



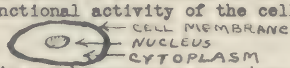
(l) Actinomyces (meaning ray-fungus, because they resemble ray-like filaments and were once thought to be fungi)are a group of thread-like bacteria which may be branched or unbranched, aerobic or anaerobic, spore or non-spore bearing. One member of this group produces actinomycoses in man and lumpy-jaw in cattle and swine. Diagrammatically they resemble:



(3) Internal Structure of bacteria has not been studied too well due to the limitations set by their size and the inability of the microscope to faithfully resolve images of bodies smaller than 0.2μ (1/5000 of a millimeter) in diameter. The only important method of studying microscopic bodies which can effectively depict bodies smaller than $.2\mu$ is the ultra-violet light photography method. By this method bodies with a diameter as small as 0.075μ (3/40,000 of a millimeter) can be faithfully resolved.

$$\mu = 1/1000 \text{ of a millimeter}$$

Some observers believe that the bacterial cell is, like every other cell, differentiated into a nucleus (a mass of differentiated protoplasm or living material which serves as the executive center of the functional activity of the cell) and cytoplasm (the rest of the material of the cell).



Others believe that the bacteria are homogeneous organisms not differentiated into nucleus and cytoplasm. But the most recent view is that the bacteria contain cytoplasm and nuclear material scattered thru it and not aggregated into a mass as the nucleus is usually defined.

Besides nuclear granules the bacteria contain other granules such as carbohydrate (glycogen), fat and lipoid (waxy substances). The functions of these granules are not known but they probably serve as the substance involved in the metabolic process of the cell.

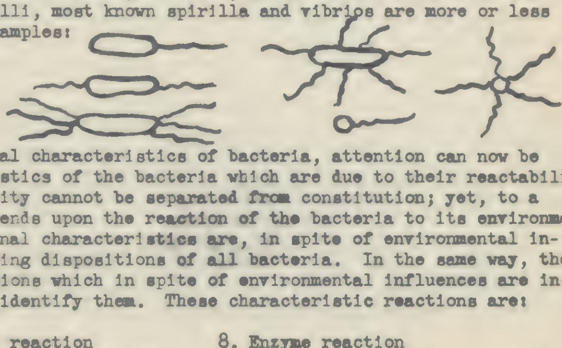
Some bacteria have the power of forming spores which from all appearances is a protective function. The spore consists of the aggregation into one mass of all the nuclear-like material and becoming surrounded by a membrane which prevents agents such as heat from destroying its life at the ordinary thermal death point of the non-sporing stage. The spores may form at the end of the bacteria, in the middle, somewhere between the middle and the end, or the whole bacterium may become changed into an ovoid shaped spore.
Example:

The spore is evidently a resting stage of these particular types of bacteria, in which it is far more resistant to adverse environmental conditions, than in its ordinary spore-free vegetative stage. Under favorable conditions they usually dissolve their spore-envelope and proceed to reproduce, grow and develop.

(4) The Cell Membrane is the outer cover just as the skin is the outer cover of animals. The membrane is very elastic and thus able to resist pressure, tension or torsion.

(5) The Cell Capsule is an outer mucilagenous covering of some bacteria such as the ones which cause pneumonia (pneumococci) and anthrax (B. anthracis). It is a thickening of the outer cover probably developed by secretions from the cell. The thickness of the capsule depends upon the environment of the bacteria.

(6) Appendages. One of the means of movement of bacteria is by hairlike out-growths from the cytoplasm of the cell. Such an appendage is called a flagellum. A great number of bacteria have no flagella. Some have one, some two, and some more than two. A few coccal forms, many types of bacilli, most known spirilla and vibrios are more or less motile by means of flagella. Examples:



REACTABILITY (Physiology)

Having surveyed the constitutional characteristics of bacteria, attention can now be turned to the various characteristics of the bacteria which are due to their reactability to their environment. Reactability cannot be separated from constitution; yet, to a certain extent, constitution depends upon the reaction of the bacteria to its environment. Previously discussed constitutional characteristics are, in spite of environmental influences, inherited and identifying dispositions of all bacteria. In the same way, there are certain characteristic reactions which in spite of environmental influences are inherent in bacteria and serve to identify them. These characteristic reactions are:

1. Colony formation and cultural reaction
2. Reaction to selective media & indicator media
3. Spore formation
4. Pigmentation
5. Cell-aggregation
6. Motility
7. Capsular swelling (Quelling)
8. Enzyme reaction
9. Staining reaction
10. Fermentation reaction & other biochemical properties
11. Serological reactions
12. Pathogenicity

1. Colony Formation. When bacteria are seeded sparcely over the surface of solid media, the individual germs multiply to form isolated colonies. The appearance of these colonies is, in many cases, highly characteristic of the group or species to which the original bacterium belonged. The character of the colonies produces by a given bacterial species is of great importance in indentification. In identifying colonies, description should be noted as to their shape, size, elevation, structure, color, transparency, surface, edge, consistency, and emulsifiability; also character of central and peripheral areas. The character of the colonies will depend on the type of media used.

When the bacteria are stabbed into a solid media with a thin rod no distinct colonies will develop, but growth will take place in most cases along the line of puncture of the media. Here should be noted the degree and extent of growth, the presence of a surface growth, the presence or absence of liquefaction of the media, the presence of gas formation.

In fluid media, colony formation is not distinguished grossly, but the clearness or turbidity of the media and gas formation should be noted.

2. Reaction to Selective Media and Indicator Media. Selective media are utilized because they contain substances that have a stimulating effect on the growth of the bacteria that are desired to cultivate, or an inhibitory effect on the growth of others not desired to cultivate. The result in either case is better growth of the desired organism. Blood serum and ascitic fluid (fluid of the belly cavity) are substances frequently used to stimulate the growth of certain organisms. Glucose and other sugars, extracts of vegetable and animal tissues, and certain salts such as potassium nitrate, are likewise used. On the other hand certain aniline dyes, phenol, telluric acid, bile salts, as well as numerous other substances are used for inhibiting growth.

Indicator Media are those which change color because they contain an indicator (a substance which changes color when the alkalinity or acidity is changed or when certain other chemical changes take place or a group of organisms cause these changes when they grow and develop upon it). Thus, if it is known that the bacteria desired to cultivate produces hydrogen sulphide (H_2S), lead acetate may be added to the media.When the H_2S is developed the colonies become colored brown. In this way the H_2S producing colonies can be identified from other colonies. Colonies of organisms which ferment sugar are colored red if either of the two dyes, lithmus or neutral red, are added to the media. The red color is produced because fermentation produces acid, and acid causes the two dyes to become red. Many other indicators are available.

Sometimes selective and indicator media are combined in one media.

3. Spore Formation. This ability of some bacteria to form spores was previously discussed in considering the internal structure of bacteria. Since structure and function are so interdependent it is difficult sometimes to discuss even abstractly the one without the other. The function of spore-formation is a character which not many of the bacteria possess. It is a protective mechanism as far as can be ascertained, since only under adverse environmental conditions are spores formed. In this apparently dormant state, they are able to withstand with much impunity conditions which might otherwise be lethal. For example, heating a mixed culture of many types of bacteria at 80°C for 10 minutes will destroy all vegetative non-sporing bacteria, while spores remain unaffected. Milk which has been contaminated from soil or feces, may contain a group of bacteria which are well able to withstand heat, - in fact these heat living bacilli or thermophiles, many of which are spore-bearing, grow best at temperatures around 60°C. Many even withstand boiling for hours. Such a bacterium is B. Subtilis. Pasteurization of milk does not destroy them and therefore it is important that milk used for pasteurization should be clean and have a low bacterial count before pasteurization if the pasteurized milk is expected to have a low bacterial count. Other bacteria will form spores under low temperatures. Unfavorable media may cause sporulation.

4. Pigmentation. Many bacterial species produce a distinctive pigment, which sometimes as with Staphylococcus aureus (producing a yellow pigment) remains within the bacterial cells, and sometimes, as with B. pyocyanea (producing a bluish-green pigment) diffuses throughout the media upon which it grows.

Pyocyanin, the pigment produced by B. pyocyanea, has the two-fold and opposite functions of being oxidizable and reducible and probably plays an important part in the metabolism of this type bacteria. It seems likely that other bacterial pigments may play an analogous and probably a decisive role in cell metabolism.

5. Cell Aggregation. The property of cell aggregation has already been discussed in considering the various forms of bacteria. Again it becomes difficult to separate form

from function, since, although the aggregation of cells may rightly be considered as in the category of form, yet the character of the aggregation is also determined by the function of the bacteria. Staphylococci usually aggregate in grapelike bunches, but under certain circumstances may appear as diplococci, streptococci, with or without any form of aggregation. Sometimes a bacillus may resemble a cocci and vice versa. Cell aggregation is apparently a function of bacteria and is influenced by environmental vicissitudes and the process of cell division (reproduction).

6. Motility. The motility of bacteria is another method of identification. The usual means of motility is by hairlike outgrowths called flagella. Such bacteria as those producing typhoid fever (B. typhosum), some of those ordinarily found in the intestinal tract (B. coli) and many other actively propel themselves through fluid media by means of flagella. The passive movement of bacteria in fluid media due to Brownian movement (molecular motion of the media) must not be confused with actual motility.

If spirochetes are considered as bacteria, active motion with them is due to the undulating movement of the whole body of the organism (like the movement of an eel or snake). Spirochetes do not have appendages such as flagella. Motility in bacteria, therefore, may be due either to undulating body motion or flagellar movement. The motility may be greater or less, depending upon circumstances.

7. Capsular Swelling. Not all bacteria have capsules. Among the ones which do have capsules, the pneumococci (pneumonia producing bacteria) have been the most important ones studied recently. The capsular swelling among these bacteria is being used as a means of diagnosing the various types producing particular cases of penumonia. In this way, the correct serum can be used in treatment.

The degree to which the capsule is developed is largely determined by the environment. Thus, the pathogenic capsulated bacteria (such as penumococci)show their maximal capsule formation when growing in animal tissue such as the lungs. When such bacteria are grown in artificial media, there is usually a high correlation between the degree of capsulation and the animal protein content of the media. The less altered the animal protein, the greater the degree of capsulation. Whether the capacity to form a capsule is really confined to those species that are typically capsulated is very doubtful. Many observers have described capsule-formation by normally non-capsulated forms under particular environmental conditions.

8. Enzyme Reaction. See previous discussion on enzymes.

9. Staining Reaction. One of the greatest discoveries in bacteriology was that various types of bacteria when subjected to various types of dyes, will become characteristically stained. By this method, identification of the various of microorganisms is possible. In some cases, the whole bacterial cell may become uniformly stained. In some rod forms, the ends of the bacillus may become deeply stained, while the central portion may remain almost colorless. This is called polar staining and is characteristic of the plaque bacillus (Pasteurella Pestis). It is found in other bacterial species as well. Sometimes the cell may stain unevenly throughout its length so that barred or beaded forms may occur. This is very characteristic of the diphtheria bacillus and many allied organisms. It occurs to a less marked extent with the bacilli of the tuberculosis and leprosy groups.

Simple staining technique has developed into many complex procedures. Two of the most common methods of staining employed in diagnostic procedures are:

a. The Gram Stain. This reaction depends on the fact that when certain bacteria are stained with certain aniline dyes, such as gentian-violet, methyl-violet and others, and are subsequently treated with a solution of iodine in potassium iodide, a mordant action (fixing the stain) occurs which prevents subsequent decolorization of the bacteria when treated with alcohol. Other bacteria, after similar treatment are readily decolorized. Those bacteria retaining the stain are called gram-positive bacteria; those not retaining the stain are called gram-negative bacteria. This method of staining classifies all bacteria into two large groups.
b. Acid-Fastness. The acid-fast method of staining is so named because certain bacteria after being stained with warm solutions of fuchsin dye, resist the decolorization action of strong mineral acids. These acid-fast bacteria include the tubercle bacilli groups (tuberculosis).

10. Fermentation Reaction and Other Biochemical Properties. In bacterial differentiation, the biochemical reactions of the bacteria to certain substances are often of great importance. In many groups of organisms the classification is made on the basis of ability of the bacteria to ferment sugars or split up proteins (proteolysis), or of both abilities considered together. The sugar tests especially afford a means of bringing out the finer

distinctions between closely allied organisms. The ability of bacteria to cause oxidation of tartrates and citrates is employed in differentiation of the group of bacteria known as the coliform group (group of closely related bacteria found in feces, water and soil).

Not only do differentiation tests depend upon fermentation of certain carbohydrates and alcohols (colloquially spoken of as "sugars"), and upon protein splitting (proteolytic) powers of bacteria, but also upon ability to split fats, to reduce certain dyes such as methylene blue and litmus, or certain salts such as nitrite and tellurite, to produce catalase (an enzyme which decomposes hydrogen peroxide) to produce indole from peptone, to form ammonia gas (NH_3) and hydrogen sulphide (H_2S) gas, to utilize certain salts such as tartrates and citrates, and to change the acid-alkali (the pH) of glucose broth.

11. Serological Reactions. When germs attack the human being or other animals, the body is either overwhelmed by the attack and dies or else it builds up a defensive and protective mechanism which overcomes the adverse effects brought about by the attack of the germs. This ability to overcome the invasion ratio is known as the immunity mechanism of the body. The reaction which the germs produce in the body can be detected by certain technical examinations of the blood serum. The immune reaction causes certain elements to become present in the blood serum which are called antibodies. There are a number of such antibodies which an immune reaction produces, among which are those called agglutinins, precepitins, antitoxin, lysins, and opsonins. Each germ usually produces a specific group of antibodies. Because these antibodies are usually specific, they can be detected by certain tests and can give excellent information as to the type of germ which caused a particular disease. Some of the tests which are based on this principle are the Wassermann test (for syphilis), the Widal test (for typhoid fever), the Schick test (for diphtheria), the Dick test (for scarlet fever).

12. Pathogenicity (Ability to Produce Disease). The ability of a bacteria to produce disease depends on the nature of its reaction in the body of a host. This reaction depends on the nature of the germ and the nature of the body of the host. Some bacteria will produce disease in man but not in many other animals; others will produce disease in various animals but not in man. Why one germ is pathogenic to man and another germ non-pathogenic is not exactly known, except that philosophically a substance is poisonous or a germ is pathogenic when it reacts unfavorably to the constitution of the body.

THE GROWTH AND DEATH OF BACTERIA

Having considered the dynamic aspects of growth of bacteria, as affected by temperature, food and other factors, the statistical aspects of growth, i.e., growth as affected by the rate of change in the bacterial population, must be considered.

If a given bacterium is seeded into a liquid medium of suitable composition and incubated at a suitable temperature, it will be found that growth will follow a definite course. This course may be arbitrarily divided into four phases:

1. The lag phase, lasting for a few hours, during which multiplication is slow. In the early part of this phase there may be no apparent growth; in fact many of the organisms may die, so that there is an actual diminution in their numbers. Within a short time, however, growth becomes apparent, and gradually increases in pace till the beginning of the next phase. Although growth in numbers is slow in this phase, there is an increase in size and activity. The lag period will be shortest under the following conditions: (a) If the inoculum is large. (b) If the culture is young. (c) If the culturesare frequently transplanted. (d) If the temperature is optimum. (e) If the medium is optimum. (f) If the inoculum is in the logarithmic phase.

Each type of organism has a different length of lag period.

2. The logarithmic phase is that period during which reproduction of the organism takes place at maximum speed. This phase lasts a little longer than the lag phase. The rapidity of reproduction will be greatest when: (a) The temperature is optimum. (b) The medium is optimum.

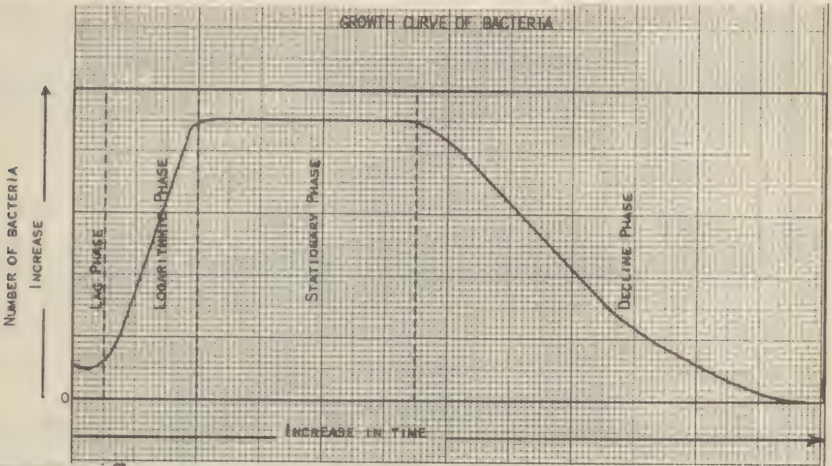
Each type of organism has a different generation time.

3. The stationary phase is the next period during which the organisms cease to multiply at maximal speed, so that their increase in number becomes less and less until it ultimately ceases. The number remains approximately constant for an appreciable length of time. During this phase, the number of freshly formed bacteria roughly counter-balance the number of those that are dying. The reason for this decline in the reproductive power of the organism is unknown.

4. The decline phase is the next period. During it, the organisms gradually diminish in number over an interval of days, weeks or months till all the organisms are dead. The

reasons for this decline and self-sterilization is not known, but it is thought to be due to: (a) Exhaustion of food stuff. (b) Concentration of population. (c) Accumulation of toxic waste products.

The growth curve of bacteria indicating the above 4 phases roughly resembles the following:



THE NITROGEN CYCLE

1. General Considerations. The general principles of growth and development of bacteria applies to all forms of living organisms, large and small. As previously indicated, the principles involved in the relationship of the forces of environment to heredity and constitution to reactability pertain alike to all living material. Though the general principles of growth and development relate to all forms of life, there are special types of activities which are inherent in special groups of organisms and these are peculiar to these specific groups and to no other. For example, man has the special capacity for creating mental pictures of things before reproducing them in reality; bees have the special ability of extracting nectar from flowers and storing it away as honey; plants have the special power of producing carbohydrates by utilizing the action of the sun's rays (photosynthesis); and plants synthesize proteins. In the same sense certain groups of bacteria have the special ability of changing organic nitrogen to inorganic, while other groups of bacteria have the special ability of changing inorganic nitrogen to the organic state. This continuous change between the organic and inorganic state of nitrogen effected by bacterial action is called the "nitrogen cycle". This cycle is the chain of processes that links the inorganic and organic existence of matter in the vast scheme of movement that takes place on this earth and it is, therefore, one of the most important processes in the growth and development of living things. Without this special activity of certain bacteria the chain in the process of the continuance of life would be broken and living matter would disappear from the earth.

   Ultimately, the nitrogen cycle is a series of oxidation-reduction reactions. Besides this cycle, there are such cycles known, as for example, the carbon cycle, sulphur cycle and phosphorus cycle, but the nitrogen cycle is by far the most important, not only in relation to life, but also in relation to sanitary science, and has special significance in preventing soil pollution, in purification of water, and in the adequate disposal of sewage.

   The nitrogen cycle is a process by which simple inorganic nitrogen or nitrogen compounds are built up into complex living organic matter (protein in character) and then broken down again into simple inorganic nitrogen or nitrogen compounds etc. The building up process (anabolism) is dependent on bacterial activity and largely associated with plant life (but not always); the breaking down process (catabolism) is chiefly brought about through bacterial action.

   The supply of compounded nitrogen is comparatively small upon the earth, and yet this compound nitrogen is of vital importance to all life. The supply of simple nitrogen upon the earth is very great, making up four-fifths of the atmospheric gases. Nitrogen exists in plants and animals mainly in the form of protein. Enormous quantities of

nitrogen flow away in sewage or litter the earth as a result of dying plants and animals. If the nitrogen cycle were to stop, the pollution of water and soil would become very great in a short period of time due to cessation of the self-purification process. Life would soon cease due to the failure of the rebuilding of nitrogen into protein which is essential to life.

2. Decomposition. As soon as an animal or plant dies its protein constituents begin to decompose and are aided in the process of decomposition by putrefactive bacteria. Decomposition usually results from bacterial activity, but it may take place also as a result of physical, chemical or electrical agencies. In considering the process of self-purification, we deal mainly with bacterial decomposition: (a) Fermentative decomposition. (b) Putrefactive decomposition.

   Fermentative decomposition refers to the breaking down of carbohydrates with the formation of acids (lactic, acetic, butyric) alcohol, carbon dioxide.

3. Putrefactive Decomposition. Putrefactive decomposition is literally a process of offensive decay. It is generally restricted to include only those processes of protein disintegration which give rise to foul smelling products. For practical purposes, it consists of the decomposition of organic matter, usually protein in character, due to bacterial action.

   In the process of self-purification, "putrefactive decomposition" is a phase of importance in the series of processes involved in the "nitrogen cycle".

   When putrefactive bacteria attacks dead animal or vegetable matter, they cause it to be broken up into simpler products which strikingly resemble the digestion of protein material in the stomach and intestines. Some of the putrefactive bacteria produce proteolytic (protein splitting) enzymes which liquify the protein (such bacteria are B. subtilis and B. proteus). Other bacteria, of the type found in the large intestines, can break down protein without any evidence of liquefaction. For the most part, the bacteria which are pathogenic for man are killed during the process of putrefaction. In order for the processes of decomposition to take place the protein material must contain the necessary moisture, warmth, and other conditions essential for bacterial activity. The breaking down of vegetable matter is slower and more difficult than the breaking down of animal matter.

4. Mineralization. The breaking down of the complex protein molecule to simpler and stabler compounds is usually spoken of as "mineralization", and may be regarded as a series of oxidation. According to our present chemical conception, it is really a series of hydrolyses (hydrolysis is a process of double decomposition by the addition of water, i. e., a compound plus water forms two new compounds by the splitting up of the original compound and the water. Example, $PCl_5 + 4\ H_2O$ gives $5\ HCl + H_3PO_4$, i.e., phosphorus pentachloride plus water produces hydrochloric acid plus phosphoric acid). By this same process, the complicated molecular structure of protein is split up into amino compounds of simpler and simpler composition until nitrogen appears in the form of ammonia (NH_3). Although little is known of the chemistry of the early stages of protein decomposition, the simpler breakdown substances are known to be proteoses, peptones, amino acids and other amino substances, as well as organic acids, indol (C_8H_7N) and phenol (C_6H_6O). Finally, the end products are hydrogen sulphide (H_2S), mercaptan (sulphurated alcohol), carbon dioxide (CO_2) and ammonia (NH_3). This destructive action occurs in the superficial layers of the soil.

   In the nitrogen cycle, the end product of the nitrogen contained in the organic matter is ammonia. Ammonia, as such, cannot be used by the plants. Some of it may escape as a gas into the atmosphere, but for the most part it is retained in the soil (after reacting with chlorides and carbonates) as ammonium chloride or ammonium carbonate. But with this the mineralization process is not yet complete for ammonium salts are not very stable and therefore are not found in large quantities in nature under ordinary conditions. The most stable and most abundant compounds of nitrogen found in nature are in the form of nitrates. The transition of ammonium salts to nitrates was a mystery until, in 1888, Winogradsky made one of the most brilliant discoveries in bacteriology. Through his epoch-making work he showed that there are present in the soil and soil water, two distinct types of bacteria: one, the nitrosomonas, which are capable of producing a special ferment that oxidizes ammonium compounds into nitrates; and another, the nitrobacter, which by a special ferment oxidizes the nitrites into nitrates. This is known as the process of nitrification.

   Ordinarily, the nitrates go into solution in water and are either taken up by the roots of plants or washed away. In a sanitary analysis of water taken from the soil, there-

fore, the presence of nitrites and nitrates are significant. Nitrites indicate pollution with active bacterial breaking down of organic matter. Nitrates <u>alone</u> indicate past pollution. This ends the breaking down (catabolic) phase of the nitrogen cycle. Thence begins the building (anabolic) phase: inorganic nitrogen to complicated organic substances.

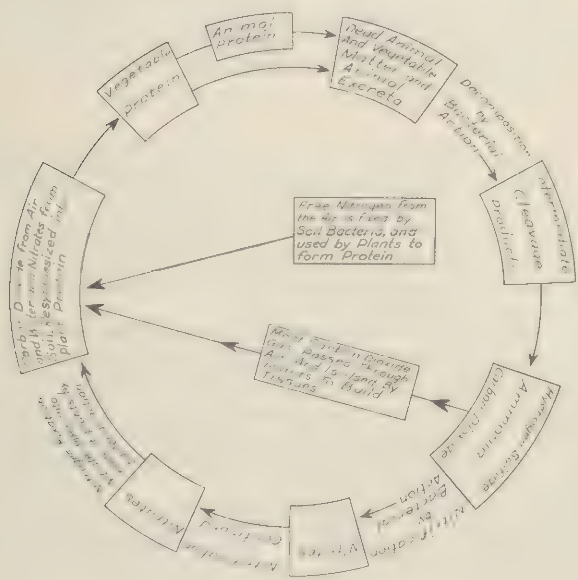
5. <u>Nitrogen Fixation</u>. The rebuilding phase is known as nitrogen fixation, which is initiated by bacteria. Two groups of bacteria possess nitrogen fixing power: (1) the "non-symbiotic" group which live in soil and with energy obtained from carbon dioxide build complex nitrogenous compounds from the nitrogen of the air and (2) the "symbiotic"group which live on the nodules of legumes (peas, beans, clover, peanuts) in a mutually advantageous association and build more complex nitrogen compounds from the inorganic nitrogen found in the soil. This briefly completes the remarkable phenomenon of nitrogen fixation.

The entire cycle from proteolysis to mineralization of the organic matter, nitrification, oxidation and reduction, as well as the fixation of free nitrogen from the atmosphere is due to bacterial action. Each stage is accomplished by special bacteria growing under special conditions. Nitrosomones oxidize ammonium carbonate and nothing else. Nitrobacters are equally specific in oxidizing nitrites to nitrates. Protein decomposition occurs in stages as a result of bacterial action largely specific for each step for few microorganisms attack native protein. After the decomposition is started, special organism or groups continue the process. Some of these putrefactive organisms are aerobic; others anaerobic.

It is important to remember that practically the entire cycle takes place upon the surface and in the upper layers of the soil. A few feet below the surface of an undisturbed area the soil contains few or no bacteria. Sewage placed too far below the surface, does not profit by the nitrogen cycle in its entirety, and under such circumstances incomplete nitrification occurs. Nature's method of disposing of dead waste is defeated, and pollution of the soil and infection of the ground water may result.

Reference: <u>Elementary Bacteriology</u>. Greaves.

The Nitrogen Cycle



Bacteriology of Water

It is convenient to divide the bacteria found in water into three groups:

A. Natural Water Bacteria. In this group are included organisms commonly found in waters free from gross pollution. These may be subdivided as follows:
   1. Bacilli. (a) Fluorescent, producing a fluorescent pigment on culture media. (b) Chromogenic, producing red, orange, yellow, or violet pigment on culture media. (c) Non-chromogenic, producing no pigment on culture media.
   2. Cocci. (a) Chromogenic, color producing, usually yellow on culture media. (b) Non-chromogenic, producing no pigment on culture media.
   3. Sarcina. A group distinguished by their peculiar arrangement in bundle formation.

B. Soil Bacteria. These organisms, though not normal inhabitants of water, frequently wash into it during heavy rains. Most of them are aerobic spore-bearing bacilli, such as B. subtilis, B. vulgatus. Others such as Bact. aerogenes and Bact. cloacae, which appear to live most frequently on grain and plants, and which may conveniently be treated as soil organisms, are aerobic non-sporing bacilli.

C. Sewage Bacteria. Many of the organisms of this group are normal inhabitants of the intestines of men and animals. Others live chiefly on decomposing organic matter of either animal or vegetable origin. Occasionally pathogenic organisms are included.
   1. Intestinal Bacteria. Bact. coli group, streptococcus fecalis, Clostridium Welchii. Pathogenic organisms such as Bact. typhosum and V. cholera.
   2. Sewage Bacteria. Proteus vulgaris, Clostridium sporogenes, etc.

Factors Determining the Kinds and Numbers of Bacteria in Water:

A. Type of Water. Waters may be divided according to their source into (1) surface and (2) ground waters. The former comprise all those that are found on or near the surface of the earth, and that have not been filtered through any considerable thickness of soil; the latter comprise those which in order to reach the underground stratum that they occupy, have percolated from several feet to several hundred feet, through porus layers of soil. Since surface waters are frequently exposed to contamination from dust, soil, sewage, factory wastes, and other decomposing organic matter, they may contain large numbers of bacteria, many of which are of intestinal origin. Ground waters, on the other hand, are generally pure, having had most of their surface contaminants filtered off on their downward passage through the soil; and though it is not unusual to find bacteria in larger numbers than one would expect, these are generally of a harmless type.

   Surface Waters

   (a) Rain. In falling to the earth, the raindrops come into contact with particles of suspended dust, and carry these down with them. The more dust there is in the atmosphere, the greater is the bacterial count. Therefore the greatest numbers of organisms found in rain water is in the warm dusty months.
   (b) Snow. This tends to be less pure than rain, probably because the snow flakes have a greater surface on which to collect suspended particles in the atmosphere; and also because their low temperature conduces to the survival of bacteria. In snow situated on the tops of high mountains, where Pasteur found the air to be particually sterile, there are hardly any organisms.
   (c) Hail. Curiously enough, hail contains more bacteria than either rain or snow. During the formation of hail, it seems probable that rapidly ascending currents of air carry the raindrops up into a region of atmosphere where they are solidified; falling down they are melted, and again swept up and frozen. After they have been frozen and thawed a number of times the hailstones are thrown out on the periphery of the storm center and finally come to earth. It is suggested that the air currents carry up to the cloud regions quantities of dust, which is thus incorporated in the hail. It is difficult to explain in it otherwise the presence of vegetable cells, and of fluorescent and soil bacteria.
   (d) Ice. The number of organisms in ice depends on the nature of the water from which the ice is formed. With the exception of the ice of glaciers, it is generally impure. Its low temperature is favorable to the survival of most bacteria; hence the self purification that occurs in waters on storage occurs hardly at all, or very slowly, in ice.
   (e) Upland surface waters. If derived from open wasteland that is protected from human and animal excretion, these waters are relatively pure. Most of the organisms they

contain belong to the soil group of bacteria.

(f) Rivers. In most countries rivers are heavily contaminated, and contain not only the natural and the soil bacteria, but large numbers of organisms derived from sewage.

(g) Lake waters. Owing to the natural storage of water in lakes, there is a continuous process of self-purification occurring; hence, lake water is purer than streams that feed it. Water taken from the middle of the lake contains fewer organisms than that taken near the shore.

(h) Sea water. The number of bacteria in sea water is generally less than in fresh. In deep sea the bacteria seem to be distributed evenly, there being almost as many near the bottom as on the surface. The ooze on the bed of the oçean is very rich in bacteria.

Ground Waters

Some of the purest waters that we know come from deep wells and springs. Fifteen driven wells in the neighborhood of Boston Mass. contained an average of only 18 colonies per c.c. when cultured on media for determining the bacterial content. The purity of springs depends mainly on their source and surroundings. In waters which have percolated through thick strata, the flora differs from that in surface waters; usually, the chromogenic type of bacteria are found in this case.

Shallow wells, if protected from contamination in the immediate vicinity by concrete sides, and if provided with a sanitary pump system, may contain relatively few bacteria. This may not always be true, since the water at the shallow level may be grossly contaminated due to the character of the soil porosity and formations of the earth strata. It can generally be expected that open wells or ill outfitted wells are heavily contaminated from dust and surface washings.

It can generally be said that the further water percolates through the ground, the purer it will be if no other factors tend to vitiate the filtration effect on the water; for example, such as deep crevices in the earth, extensive layers of gravel unmixed with sand, and unexpected peculiarities in the earth's strata. The types of earth which give the best water supplies are those whose particles are not too fine or cemented together (in order to allow ample water to percolate through it), and those whose particles are not too large (gravel) to allow too rapid percolation and, therefore, too little effective filtration.

The following table may be helpful:

	Minimum Filtration but Ample Water Supply	Adequate Filtration but Diminished Water Supply	Adequate Filtration and Adequate Water Supply
Lime Stone Sand Stone	xxxx When creviced		xxxx When not creviced
Fine Sand		xxxx	xx
Clay		xx	
Sandy Loam			xxxx
Coarse Sand	x		xx
Gravel	xxxx		

Each x emphasizes the affirmative.

B. Nutrition. The amount of available food supply is probably the most important factor of all in determining the number of bacteria in a given water. When organic matter is plentiful, organisms abound; when it is scarce, they are few, and tend to die out.

C. Temperature. The effect of temperature varies with amount of organic matter present. A rise of temperature in a water containing ample food supply for the bacteria causes them to multiply rapidly; but when the organic matter is small in quanity, a rise in temperature has the reverse effect; this is probably due to early exhaustion of the food supply, and the consequent diminution in rate of multiplication of the bacteria.

A low temperature, independent of the amount of organic matter present, favors the survival, though not the multiplication of bacteria. Houston (1913) added typhoid

bacilli to raw Thames water, and maintained the samples at temperature varying from 0°C to 37°C. The initial number of organisms was 103,328 per c.c. of water. The following table illustrates the results: (1)

Degrees	Number of Bacilli per c.c. Surviving After Weeks								
	1	2	3	4	5	6	7	8	9
0°C	47,766	980	65	34	3	3	2	1	0.0
5°C	14,894	26	6	3	0.3	0.1	0.0	-	-
10°C	69	14	3	0.3	0.0	-	-	-	-
18°C	39	3	0.4	0.0	-	-	-	-	-
27°C	19	0.1	0.0	-	-	-	-	-	-
37°C	5	0.0	-	-	-	-	-	-	-

D. Light. It has been asserted that the ultra-violet rays of the sun play an effective part in destroying microorganisms in water. Procaccini (1893) placed drain water, from which the coarser particles had been removed, in glass cylinders 50 cms. deep, and exposed them for 6 hours to the Italian sun in June. A control cylinder was protected from the light. The results obtained were as follows: (1)

	Insolated Cylinder Bact. per c.c.	Darkened Cylinder Bact. per c.c.
Before Exposure		
Surface	4,900	4,900
Middle	4,510	4,510
Bottom	6,781	6,781
After Exposure		
Surface	0	7,261
Middle	2	9,051
Bottom	8	12,591

It would appear that under laboratory conditions the actinic rays of the sun may exert a bactericidal effect. In nature, however, the conditions are altered. One of the main factors hindering the rays is the opacity of the water, which prevents their penetration for more than a short distance. Even in clear water, it is doubtful if they are active for more than a distance of 5 feet from the surface. Another factor is the movement of the water, which may prevent any single organism from being subjected to the rays for a sufficient time to kill it. Ultra-violet rays generated from a mercury vapour lamp have been used in the artificial purification of water; for this purpose, it is essential for the water to be exposed in shallow layers.

E. Acidity. Many natural waters have an acid reaction. Though it is difficult to estimate the effect of acidity on the destruction of bacteria and on the inhibition of their growth, there is little doubt that it does play a considerable part in purifying some waters. It appears that the disinfectant action of mineral acids is proportional to the number of free hydrogen (dissociated hydrogen) per unit volume. The organic acids are only slightly dissociated, so that their H-ion concentration is relatively low. As, however, they have a markedly germicidal effect, it must be concluded that this is a property of the whole molecule, or possibly to some extent of the anion (positively charged ion. The hydrogen is negatively charged).

F. Salinity. The effect of salt solutions on growth of bacteria depends upon the concentration of the solutions, the types of salts, and the combination of salts. Such salts as Ca Cl_2, Mg Cl_2, NH_4 Cl, Na CL, and K Cl stimulate Bact. coli in very low concentrations and inhibit their growth in higher concentration. Na Cl in 0.85 solution causes disintegration of the meingococcus, but when a calcium salt is added to the solution the disintegration will not occur. It is probably this factor of amounts and kinds of salts in solution that accounts for the difference both in the number and types of bacteria found in sea water.

G. Dissolved Oxygen. Bact. typhosum and Bact. coli remain viable in sterile water containing dissolved oxygen much longer than in water kept under anaerobic conditions. Bact. typhosum in an experiment, survived in filtered tap water exposed to the air at room temperature for nearly 2 months, but died in 4 days in an atmosphere of hydrogen. This suggests why this organism dies more rapidly in polluted than in pure water, and why it survives for a shorter time in summer than in winter. The importance of oxygen in favoring growth and survival of aerobic and facultative anaerobic organisms has already been explained elsewhere.

H. Protozoal Content. Protozoa are unicellular animals as compared with bacteria which are unicellular plants. A number of studies have indicated that the presence of large numbers of protozoa of the flagellate and infusoria types will cause a destruction of the bacterial life of the water.

I. Rainfall. The effect of rainfall on the bacterial content of a water is complicated. Rain falling after a drought washes large numbers of soil organisms into the water, and hence increases the number of bacteria. If the rain continues for some days, relatively few organisms may be carried in during the later period of rainfall, so that the stream is diluted with water purer than its own. Its bacterial content therefore sinks. Again, the nature of the water is of importance. A relatively pure stream may be contaminated by rain; an impure stream may be benefitted by dilution. As a rule, rivers and upland surface waters contain their greatest numbers of bacteria after heavy rainfall.

J. Season. The monthly variation in the bacterial content of waters depends chiefly on the temperature and rainfall. The highest counts in the Thames river are found in the winter months when the temperature is low and the rainfall greatest. In the summer many sources of pollution may dry up and much of the water in the rivers may be filtered water, derived from underground sources of supply, hence the bacterial content may be low. In countries in which the water supply is augmented by melting snows, the bacterial content rises considerable in spring time. The high bacterial content of water in winter and the greater survival of organisms at a low temperature is reflected in Veldee's studies of typhoid fever mortality along the Ohio Valley as outlined below:

Typhoid Death Rate - Seasonal Variation

	Group using raw water and having good sewage	Group using good water but having poor sewage
January	10.1	3.3
February	7.3	2.7
March	8.5	2.7
April	10.9	3.3
May	12.9	3.3
June	7.7	6.5
July	5.7	12.5
August	6.1	19.0
September	4.9	11.4
October	4.4	17.4
November	9.3	12.0
December	12.1	6.0

Raw water and good sewage results in greater mortality in winter. Good wator and poor sewage results in greater morality in summer time.

K. Storage. The simple storage of water in a reservoir suffices to decrease its bacterial content enormously. It was found (Houston 1913) that after only 15 hours storage of river water, it showed a reduction in the agar count of 40%. Storage acts in 3 ways: 1. Sedimentation: The organisms adhere to particles of suspended matter, and those in clumps sink to the bottom leaving the supernatant water purer. 2. Equalization: This factor comes into play only when several waters of different qualities are collected into one reservoir. It ensures a thorough mixing of the different waters, and prevents the excess distribution of a bad supply on any one day. Even in a river the water may not be homogeneous; samples taken from one side may be different in their bacterial content from those taken near the other side. In a reservoir, natural or artificial, homogeneity is attained. 3. Devitalization: The organisms die in large numbers, probably from lack of food supply, and ingestion by protozoa. It is probably owing to storage that lake waters are so much purer than the streams that feed them. Some rivers with a very low gradient may offer conditions suitable for sedimentation.

L. Filtration. Natural filtration occurs on a large scale, resulting in the accumulation of the underground deposits of water that are tapped by deep wells and main springs. Its efficacy in the removal of bacteria depends on the nature of the soil, and the depth of the strata penetrated. In loose, porous soils a greater depth must be traversed to ensure the same degree of purification that is attained by filtration through a more compact soil. Evidence suggests that, in a soil of moderate density, the greater part of the bacteria are removed in the first 10 or 15 feet. This is the reason why deep well water is so pure. Artificially, sand filtration is used to remove bacteria from water in order to render it potable.

M. Bacteriophage. A bacteriophage is an ultra-microscopic living agent which attacks specific organisms and causes their destruction. It is known that certain types of microbes are unable to survive long in certain waters. Examples: The cholera vibrio is unable to survive long in the waters of the Ganges River, the typhoid bacilli are unable to survive long in the Rhone River, the Shiga dysentery bacilli are unable to survive long in the sea water at Havre. It is believed that these and other similar specific inhibitory actions of waters may be due to the action of bacteriophage. There appears to be a close similarity between filterable viruses and bacteriophages. Bacteriophages are pathogenic to particular types of bacteria.

SELF-PURIFICATION OF RIVERS

From what has already been said, it is clear that the number of bacteria in a particular sample of water is determined by several factors, the precise effect of which it is difficult to assess. It is also clear that such factors as absence of organic matter, the presence of numerous protozoa, a high acidity, and the opportunity for sedimentation, are able to bring about a considerable reduction in the bacterial flora. It is not surprising, therefore, that rivers that have been heavily polluted by sewage may regain their natural purity after flowing for some distance. Jordan's (1900) observation on the Illinois River are of interest. The portion of the river that he examined was between Morris and Ottawa. Nine miles above Morris two tributaries unite, the relatively pure Kankakee, and the Desplaines, laden with Chicago sewage. During its flow of 24 miles from Morris to Ottawa, the river improved in purity in spite of the absence of dilution with fresh water. The observations were made in October and November when there was neither sun nor rain. (1)

Distance from Morris	Number Colonies per c.c.			No. of hourly Analyses
	Rt. Bank	Middle	Lf. Bank	
Upper Station, Morris	261,000	204,000	29,000	3
Middle Station, Seneca - 12 mi. (24 hrs.)	100,000	49,000	35,000	2
Lower Station, Ottawa - 24 mi. (48 hrs.)	11,500	10,700	13,500	2

The extraordinary degree of purification that occurred was accounted for partly by the slow movement of the river, which permitted sedimentation to occur, and partly by the absence of sufficient food supply to support the large number of contaminating organisms.

The self-purification of stream heavily polluted by sewage sets into motion a series of physical, chemical and biological reactions that are more or less interdependent. The activity set up may be divided into 4 zones:

ZONE I - The stretch of the stream confined to just below the outfall of sewage. (a) The water is turbid and of gray color. (b) There is a decreased penetration of sunlight into the water and a decrease in green plant life. (c) The bacterial activity is increased producing a decomposition of organic material which renders the water unfit for all life except very primitive organisms (bacteria, fungi, protozoa). The increased number of microorganisms causes the oxygen to be used up quicker than reaeration can supply it. This aids in the death of fish and higher forms of organic life that require a certain adequate amount of dissolved oxygen in the water for maintaining life. (d) Much suspended matter settles to the floor of the stream, producing a sludge in which red worms, fungi, bacteria and protozoa live.

ZONE II - A longer stretch of the stream below Zone I. (a) There is heavy pollution, grayish color, offensive odor and gas bubbles with a sticky black sludge on the floor of the stream. (b) Further decomposition of organic matter occurs by reducing and splitting processes which produce soluble and gaseous compounds. The end products become very much simplified. (c) If oxygen is plentiful, no nuisance is created. If O_2 is low, the microorganisms extract their O_2 from such minerals as nitrates, nitrites, and sulphates, and finally from the organic material itself. This reduction of O_2 produces an increased growth of anaerobic organisms resulting in septic conditions which cause extreme offensiveness. (d) At the end of this zone, the re-aeration may be great enough to allow enough of O_2 absorption for more highly organized life to become established. There is also a decrease in microorganisms.

ZONE III - The next stretch in the stream where mineralization takes place and the former appearance and aquatic life is recovered. (a) The floor of stream is covered with granular deposits rather than a sticky sludge. (b) No offensive odors or gas bubbles issue forth. (c) Oxygen is increased to complete saturation. (d) Nitrogen end products are produced; nitrites become nitrates, sulphur becomes sulphates, carbon becomes carbonates. (e) Green algae appear in water as sun rays penetrates deeper below surface and also large aquatic vegetation begins to grow. (f) Life such as crustacae, rotifers, insect larvae and fish appears.

ZONE IV - This is the next zone where the normal flora (vegetation) and fauna (animal life)

of the streams abound.

BACTERIOLOGICAL ANALYSIS

The bacteriological analysis of water is made - 1. to determine the quantity of the bacteria 2. to determine the quality or kind of bacteria (i.e., whether or not coliform types are present). Hence the five characteristics by which the coliform group is identified must be kept in mind:-

(1) Aerobic or facultative anaerobic
(2) Gas forming)ability to ferment
(3) Acid forming) lactose
(4) Gram negative bacilli
(5) Non-spore forming.

The Plate Count: This technique has the following functions -

(1) To determine the quantitative estimate of bacteria
(2) To separate into colonies the various types of aerobic or or facultative anaerobic bacteria.

In general, the analysis consists in an enumeration of the organisms or groups of organisms capable of forming colonies on a standard nutrient agar medium incubated aerobically at 37°C for 24 hours or 20°C for 48 hours, depending upon information desired. It must be remembered that different groups of bacteria will grow more readily at different temperature. Since not all the organisms in water are viable and since many viable organisms, such as these of the anaerobic and nitrifying groups, do not develop under the particular conditions which the plate count provides, and since some of the organisms occur in groups which give rise only to a single colony, it is clear that the colony count corresponds not to the total number of organisms or even to the number of viable organisms, but only to the number of bacterial units that are able to multiply under the nutritional, respiratory and temperature conditions of the agar medium. For this reason it should be reported as the "number of colonies developing per c.c.".

The technique consists in diluting 1 c.c. of water sample in 9 c.c. sterile water, giving a dilution of 1 to 10; then further diluting 1 c.c. of the 1 to 10 dilution in 9 c.c. of sterile water giving 1 to 100 dilution. 1 c.c. of undiluted, 1 c.c. of 1 to 10 dilution, and 1 c.c. of 1 to 100 dilution are planted on separate plates and incubated. This test gives a purely quantitative estimate of the contamination.

The Presumptive Test: This technique has the function of -

(1) Determining whether or not gas producing bacteria are present
(2) Determining the quantitative estimate of such bacteria

Besides a general bacterial enumeration, an attempt is made to estimate the number of bacteria in the water, and often to ascertain the proportions of the various types of these organisms. The usual technique for estimating coliform bacilli is by the dilution method in a liquid medium, which allows for the observation of gas production.- an important property aiding to differentiate coliform from most non-coliform bacilli. A series of broth lactose fermentation tubes are inoculated with appropriate graduated quantities of water to be tested. Each fermentation tube must contain at least twice as much medium as the portion of water to be tested. In some tubes 10 c.c. of undiluted water is placed; in some 1 c.c. of undiluted water; in some 1 c.c. of 1 to 10 dilution; and in some 1 c.c. of 1 to 100 dilution of water. These tubes are incubated at 37°C for 24 hours, or for 48 hours if no gas appears in 24 hours.

Formation of gas in the inverted vial in 24 hours constitutes a positive presumptive test.

Gas in 48 hours but not in 24 hours constitutes a doubtful test and must be confirmed. Such confirmation is presumptive evidence of the presence of the coliform group. The confirmed test is described below.

Absence of gas in 48 hours constitutes a negative test for presence of coliform group of organisms in the quantity of water planted.

The results are reported as either in terms such as "coliform organisms present in 10 c.c., absent from 1 c.c.", or by means of a probability table, in terms of the number of coliform present per 100 c.c. The latter method is preferable, but it must be remembered that the figure yielded is only an approximation, since the error of counting by the dilution method is extremely high. Since other organisms, such as certain aerobic spore-bearers may give rise to acid and gas in lactose broth, the count is best referred to as the "presumptive coliform count".

The Confirmed Test: This technique determines whether or not acid producing bacteria are present (true fermentation produces both gas and acid, but to make certain that true fermentation has taken place when gas is found, acidity must be demonstrated).

In this test a selective media such as eosin methylene blue agar or endo agar are used. The former has the selective action of producing black colonies in presence of fermentation (acid); the latter produces red colonies under such circumstances. Other indicators may be used. Liquid instead of solid media may be used.

One or more such plates are streaked from a tube which shows gas formation in lactose broth from the smallest amount of water tested. Such plates are incubated for 18 to 24 hours at 37°C.

The presence of atypical coliform colonies on the plate is a positive confirmed test.

The presence of typical colonies on the plate is a doubtful test and cannot be definitely considered negative, since some coliform fail to form typical colonies, or such colonies may form slowly. In such case it is always necessary to complete the test.

The Completed Test: This technique has the function of -

(1) Re-affirming the gas producing characteristic of the bacteria
(2) Re-affirming whether or not the bacteria are aerobic or facultative anaerobic
(3) Determining whether or not the bacteria are gram negative bacilli
(4) Determining whether or not the bacteria are non-spore forming.

The completed test means one which will identify the coliform group (if present) according to the definition of that group, i.e., as to whether it is aerobic or facultative anaerobic, gram negative bacilli, gas producing in lactose; non spore forming. One method of demonstrating the above is as follows:

(1) From the eosin methylene blue or endo plates fish one typical colony (round and black) or if non-typical colonies are present, fish two colonies considered most likely to be organisms of the coliform group; transfer each to - (a) Lactose broth (incubation not to exceed 48 hours). (b) Agar slant (incubate 24 hours).
(2) The following results must be obtained for a satisfactory completed test to demonstrate presence of coliform group. (a) Formation of gas in the lactose broth by single colony strain (sometimes two non-gas forming strains acting together may produce gas). (b) Demonstration of gram negative, non-spore-forming bacilli in agar culture (some aerobic and anaerobic spore-formers may produce gas) by microscopic examination.
(3) Either of the following results constitutes a negative test: (a) Absence of gas in lactose. (b) Failure to demonstrate gram negative non-spore-forming bacilli in a gas forming culture.
(4) When spore-forming lactose fermenting organisms are found, the culture should be further studied to ascertain the possible presence of bacteria of the coli-aerogenes group with the spore-bearing organisms. This may be done by transferring the culture to formate ricinoleate broth and incubating at 37°C for 48 hours. If no gas is produced only spore-forming lactose fermenters are present. If gas is produced in the formate ricinoleate broth, members of the coli-aerogenes group organisms should be verified by inoculation of a tube of standard lactose broth and an agar slant. If after 48 hours, gas is produced in the former and no spores are present in the latter, the test may be deemed "completed". If spores are present, for practical purposes the organisms of the coli-aerogenes group may be considered absent.

THE U. S. TREASURY DRINKING WATER STANDARD

One must understand that a single or a few bacteriological examinations of any water supply gives only an incomplete and often an inaccurate estimate of the bacteriological quality of the water. A more complete and accurate account can only be had by what may be called an "Historical Bacteriological Picture", i.e., a long time view. In order to approach such a picture, the U.S. Treasury Dept., after an exhaustive study of the subject, developed the following standard which is known as the "U.S. Treasury Drinking Water Standard". This standard is based on all the above described techniques, and gives a more or less precise method of estimating the bacteriological quality of a particular water supply from a long time point of view. In other words, it ties together into a sequence of events each separate examination of the water, and tells a logical story of what is going on within it.

(1) Inoculation of 5 lactose broth tubes each with a 10 c.c. portion of water sample for presumptive test. Incubate at 37° C 48 hours.

(2) Streak E.M.B. plate from all tubes showing gas within 48 hrs. for the confirmed test. Incubate 18-24 hours at 37° C.
(3) Fish typical colonies to lactose broth and agar slant (same colony on broth media) for completed test.
(4) Interpret in accordance with the following recommendations (of the advisory committee on drinking water standards - 1925, Public Health Reports Vol. 40 p. 696) (a) Of all the standard (10 c.c.) portions examined in accordance with the procedure specified above, not more than 10% shall show the presence of organisms of the B. coli group. (b) Occasionally three or more of the 5 equal (10 c.c.) portions constituting a single standard sample may show the presence of B. coli. This shall not be allowable if it occurs in more than: 1 - 5% of the standard samples when 20 or more samples have been examined. 2 - One standard sample when less than 20 samples have been examined.

NOTE: It is to be understood that in the examination of any water supply, the series of samples must conform to both the above requirements, (a) and (b). For example, where the total number of samples is less than six, the occurrence of positive tests in three or more of the 5 portions of single sample, although, it would be permitted under requirement (b), would constitute a failure to meet requirement (a). Requirement (a) defines quantity of B coli allowed, while requirement (b) defines allowable distribution of this quantity.

Definition: (1) The Standard Portion of water for this test shall be 10 c. c.
(2) The Standard Sample for this test shall consist of 5 standard portions of 10 c.c. each.

Since the above tests differentiate the coliform group of bacteria from other groups, and since the coliform group consists of several genera (escherichia and aerobacter) which are further differentiated into several species (escherichia consists of species E. coli and E. freundi; aerobacter consists of species A. aerogenes and A.cloacae), and since not all species are normally intestinal inhabitants, it sometimes becomes necessary to distinguish between the "fecal" and the "non fecal" strains in order to gain an idea of fecal pollution of water. Such a differentiation can be attained by the use of numerous special tests and differential media which will not be described here. There are also special techniques for determining pathogenic bacterial contamination of water.

INTERPRETATION OF BACTERIAL ANALYSIS

Before attempting to give an opinion on the results of a bacteriological analysis, it is essential to gather particulars of the nature of the water, the methods by which it was collected, the time of collections, and the amount of recent rainfall. It is sound practice, though not always possible for the bacteriologist to make a topographical survey of the gathering ground, so as to ascertain the extent, and the kind of pollution to which it is subject. If he is unable to do this personally, he should consult a map in which the source of the water and the immediate environment are indicated.

The whole aim of the bacteriological analysis of water is to find evidence of excretal pollution. Since one can rarely isolate directly specific pathogenic organisms such as Bact. typhosum, he resorts to estimating first of all the number of living bacteria of all sorts in the water, and secondly the number of living bacteria of intestinal origin. The greater the number of bacteria, the greater presumably, is the amount of decomposing organic matter. The more bacteria of intestinal origin there are, the more likely are pathogenic species to be amongst them. Our evidence, therefore, is circumstantial, and is frequently open to doubt.

Unfortunately absolute standards for all waters cannot be set up; but a standard for any one water can be arrived at. This is possible by frequent and regularly reported examinations which establish the range of normal variation; which is, in reality, the bacterial character of the water. Any marked deviation from the normal is at once regarded with suspicion. In a water examined for the first time and for which there are no absolute standards, it is often difficult to express more than a tentative opinion. A high agar count at 20° C, for example, may be significant or it may not; and though the sanitary survey may assist us on this point, it may take several examinations under different conditions to give data for a definite opinion.

The agar count at 20° C gives information on the amount of decomposing organic matter in the water available for bacterial nutrition. The more food there is, the greater is the number of organisms in the water. Most of the bacteria that develop at 20° C are non-pathogenic to humans, and it might therefore be thought that their number are immaterial. On the other hand, they afford some indication of the amount of extraneous organic matter available for bacterial nutrition thay may have access to the water from various sources. In general, the greater the amount of organic matter present, the more likely is the water

to be contaminated with parasitic and potentially pathogenic organisms.

The agar count at 37° C is a far more important index of dangerous pollution. Most of the natural and harmless bacteria in water do not grow readily at 37° C; the organisms developing at this temperature are chiefly of soil, sewage, or intestinal origin. Hence, standards must be more stringent for colonies growing at 37° C than 20° C.

A high 37° C agar count is often sufficient to condemn a water, though there are a number of exceptions to this rule. For example, recently sunk wells and bores are liable for some time to give an unduly high count, which decreases as the well settles. Moreover, in some waters a rise in the agar count may occur in the summer months due, not to external pollution, but to actual multiplication of the organisms. The 37°C agar count is of particular value in the control of filtration. With slow sand filters, the count on the filtered water should show a 95 to 98 percent reduction on that of the raw water. A rise in the colony count is the usual signal of defect in the filter beds and demands instant attention.

Just as the 37°C is of greater significance than 20°C agar count, so the number of coliform bacilli is a more reliable index of excretal pollution than the 37° C plate count. It is also easier to lay down an absolute standard for Bact. coli than for either of the other two counts. For example, this organism should not exceed 1 per 100 c.c. in deep well water or 5 per 100 c.c. in a shallow well or upland surface water. Its presence in greater numbers is strongly suggestive of pollution.

A distinction should be drawn between the typical coli organisms, which are usually of excretal origin, and the other types of coliform bacilli which are more often derived from other sources. Undoubtedly the fecal coli are the most delicate as an index of recent excretal pollution. With regard to the importance of the other types of coli, opinion is divided. There are those who maintain that, because these organisms are found in feces (although in small numbers) their presence cannot be neglected. There are those who draw attention to the fact that organisms of the aerogenes type are often present in infected urine and may constitute the dominant type of coliform bacilli in human feces. There are others who point out that, if recent excretal pollution has occurred, fecal coli will undoubtedly be found too, so that the presence of other types in the absence of fecal coli can generally be ignored.

The interpretation is to some extent affected by the rate at which these different organisms die out after gaining access to water. Here again the data do not provide a clear answer. The viability of these organisms in water varies with several factors. Houston (1913) found that storage of water for 15 days reduced the number of Bact. coli by 80 to 90 per cent. Gray (1932) brought evidence to show that Bact. coli dies out more rapidly than Bact. aerogenes. Ruchhoft and his colleagues (1933) found that both organisms disappeared at almost the same rate, while Platt (1935) found this rate to depend to some extent on temperature. Hamilton (1935) in China found that in the summer months Bact. aerogenes can actually multiply in water under favorable conditions.

In cases where the probable origin of coliform bacilli is doubtful, use may be made of the tests for fecal streptococci and Cl. Welchii. Both of these organisms are commonly present in mammalian feces. If they are found in significant numbers in water, they may be regarded as indicating that the doubtful coliform bacilli were probably of excretal origin. Their absence, on the contrary, points to the reverse conclusion.

On the whole, the evidence suggests that organisms of the aerogenes cloacae group tend to be rather more resistant to environmental conditions than fecal coli. Their presence in water, in the absence of fecal coli, may indicate either than contamination has occurred with non-polluted dust or soil, or that excretal contamination has occurred at a time sufficiently distant to permit the disappearance of all fecal coli organisms. Which of these explanations is correct it is impossible to say on any one sample of water without further examination.

A filtered river water (like that of a good shallow well water) should conform to the following standards:

Plate count, agar 2 days at 37°C	1 to 10 per c.c.
Plate count, agar 3 days at 20°C	10 to 200 per c.c.
Bact. coli fecal type	Less than 1 per 100 c.c.
Fecal streptococci	Less than 1 per 100 c.c.
Cl. Welchii	Less than 1 per 1000 c.c.

A chlorinated and filtered water (like that of a deep well water) should conform to the following standard:

Plate count, agar 2 days at 37° C . . . . 5 to 30 per c.c.
Plate count, agar 3 days at 20° C . . . . .50 to 500 per c.c.
Bact. coli, fecal type . . . . Less than 5 per 100 c.c.
Fecal Streptococci . . . . Less than 5 per 100 c.c.
Cl. Welchii . . . . Less than 5 per 1000 c.c.

One or two further points may be noted.

Occasionally in unpolluted deep well waters, there may be a high agar count at 20°C. This is found, as a rule, to result from the presence of a single species of organisms that has apparently gained access from the air, and multiplied abundantly. Its presence is of no importance.

The effect of rainfall in the water should be noted carefully. Speaking generally, the less the water is influenced by this factor, the better. Though rain in itself contains relatively few bacteria, it may carry in large numbers of undesirable organisms from the soil. A large increase in the number of organisms, especially if attended by a rise in the coli count, should always be regarded with suspicion.

The judgment on the potability of a water can be given only after a careful weighing of all the evidence available. It must be remembered that the mere absence of evidence indicating fecal pollution does not necessarily indicate that pollution has not taken place; all it does show is that at the time the sample was examined, there was no detectable evidence of pollution. It is partly for this reason that frequent examinations are desirable.

The recommendations of the Advisory Committee on Drinking Waters Standards, as previously outlined were reached from an analysis of results of bacterial counts on water supplies over a long number of years. These standards may be interpreted as meaning, that if a water supply complied with those standards, it would contain on an average of less than 1 coliform bacillus per 100 c.c. of water and that over a long period of time the count would not vary above 10 coliform bacilli per 100 c.c. of water.

References: (1) Principles of Bacteriology and Immunology - Topley and Wilson
(2) Standard Methods - Am. Public Health Ass.
(3) Preventive Medicine and Hygiene - Rosenau.

INTERPRETATION OF LABORATORY REPORTS

The report of analysis of samples of water may be arranged in any convenient form. In Louisiana the form of the laboratory report resembles more or less the following:

1	2		3	4	5	6
MEDIUM	LACTOSE BROTH		ENDO or E. M. B.	LACTOSE BROTH	AGAR SLANT*	FORMATE RICINOLEATE BROTH
Tube	Percent 24 hrs.	Gas 48 hrs.	24 hrs.	Replant 48 hrs.	24 hrs.	48 hrs.
A - 10 c.c.	10	5	A			
B - 10 c.c.	0	0	Neg.			
C - 10 c.c.	20	5	C			
D - 10 c.c.	0	0	Neg.			
E - 10 c.c.	0	0	Neg.			
F - 1 c. c.	5	5	1	Gas	Gram negative non-spore forming bacilli	Gas
G - 1/10 c.c.	0	0	Neg.			

REMARK AS TO QUALITY, COLI-AEROGENES GROUP (POSITIVE)
(NEGATIVE)

* This stage of the analysis usually represents the completion of the analysis. Stage 6 is carried out only in case spore forming organisms are found on the agar slant.

Explanation of Each Column:

Column 1. Here each portion of the samples which is put into lactose broth tubes (second column) is labelled by A,B,C, etc., and the quantity of each portion of water is denoted, as to 10 c.c., 1 c.c., or 1/10 cc.

Column 2. This column is divided in half. In one part is recorded the percent of gas

developed in 24 hours and in the other part is recorded the percent of gas developed in 48 hours. Any amount of gas developing in the inverted tube is considered positive. Thus, a 10 in this column means that 10% of the inverted tube becomes filled with gas; a 5 means that 5% of the inverted tube becomes filled with gas, etc.

Column 3. This column represents the results obtained after transfers have been made from positive tubes in column 2 to Endo or E.M.B. plates and allowed to incubate for 24 hours. Usually transfers are made only from that tube which shows gas from the smallest amount of water tested, i.e., if A. having a 10 c.c. portion of water shows gas development and also tube F. having only a 1 c.c. portion of water, then the transfer to the Endo or E.M.B. plate is made from the F. tube.

In this column C stands for the colon type of bacteria whose characteristic colony appearance is being wet, black, and having a metallic sheen.* A stands for the aerogenes type of bacteria whose characteristic colony appearance is being dry, black, and having a metallic sheen. * I stands for intermediate type of bacteria whose colonies may partly resemble either of the above two types but is characteristic of neither. It is atypical. Neg. means that the growth does not resemble the coli-aerogenes group. N.G. means no growth.

It is to be expected that if column 2 shows no gas production, then the analysis ends there, and the remaining columns will remain blank, since there is no logic to carry the test further in the face of negative results.

Columns 4 & 5. If colon, aerogenes, or intermediate colonies are found on the Endo plates they are replanted in a lactose broth tube and an agar slant. Column 4 denotes the results found after the lactose broth tube is incubated for 48 hours. If gas is developed then the word GAS is denoted in the proper space according as to whether the specimen was originally from tube B - 10 c.c., or from tube F 1 - c.c., or any other tube. If no gas is found then Neg. is denoted. Column 5 represents the results obtained from the agar slant, after the growth from the slant is examined under the microscope. The description of the bacteria is denoted, as to whether they are gram negative or positive, bacilli or other forms, spore forming or non-spore forming, or whether no growth is found.

Column 6. If spore forming organisms are found, further study of the coliform (or coli-aerogenes) group is made. This is done by transferring the culture from the agar slant to formate ricinoleate broth and incubated for 48 hours. Whether or not gas is formed is denoted by the word GAS, or Neg. in the proper space.

If a quantitive estimate of bacteria is required, then portions from the sample are plated on agar plates at some time when portions of the water are inoculated in the lactose broth at the beginning of the analyses. After 24 hours, the number of colonies on the agar plate are counted and recorded on the report.

SUMMARY -

Column 2. Represents the results of the presumptive test which may be either positive or negative depending on whether or not gas is found.

Column 3. Represents the results of the confirmed test which may be either positive or negative depending on whether or not any types of the coli-aerogenes group are found.

Columns 4 & 5. Represent the results of the completed test which may be either positive or negative depending on whether or not gas is formed in the lactose broth and gram negative non-spore forming bacilli are found on microscopic examination.

Column 6 is part of the completed test, and is used only when spore forming organisms are found. If gas is formed in the formate ricinoleate, then coliform organisms are present and the completed test is positive; if no gas is formed, then spore forming organisms alone are present and the completed test is negative.

When the analysis is completed the laboratory technician encircles the word POSITIVE or NEGATIVE on the report, depending upon the results.

* Black colonies are formed by coliform group on eosin methylene blue (E.M.B.) medium. Red colonies are formed on endo medium.

Public Water Supply

QUANTITY.

A. Demand and Usage of Water.
   1. Domestic water requirement
      a. Maximum reasonable household use including wastes due to carelessness = 50 gal. per capita per day.
         1) Physiological (subsistence) water requirement = 1.5 gal. per capita per day.
         2) Sanitary requirements = 10 to 20 gal. per capita per day.
         3) Rational household requirements (physiological, sanitary, etc.) = 30 gal. per capita per day.
      b. Public requirements (washing streets, fire, etc.) = 5 to 10 gal. per capita per day.
      c. Industrial requirement (average for U.S. cities) = 35 gals. per capita per day. (Ranges from 20% to 60% of total water used).
      d. Loss (due to waste and leakage in distributing lines) = 25 gal. per capita per day

The average total urban use of water per capita per day in U. S. is 120 gal.

The per capita consumption of water is small towns is 60 gal. maximum
The per capita consumption of water in small cities is 100 gal. maximum
The per capita consumption of water in large cities is 125 to 150 gal. maximum
The per capita consumption of water in rural area is 30 to 50 gal. maximum.

Consumption per head (cattle & horses) = 8 to 10 gal. daily (includes feeding and sanitation)

Consumption per capita is calculated by the following formula:

$$X = \frac{Y}{365 \times P}$$

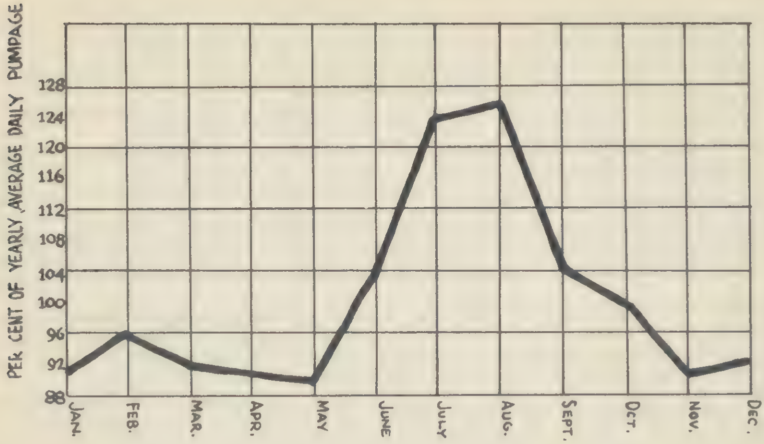
X = consumption in gallons per capita per day
Y = total number of gallons delivered into distribution system in 1 year
P = total population of district served by distribution system.

Comparison of water consumption in various cities:
Beverly Hills' use is 275 to 600 gal. per capita per day
Chicago's use is 300 to 350 gal. per capita per day
New York's use is 250 to 275 gal. per capita per day
Baltimore's use is 125 to 135 gal. per capita per day
London's use is 50 to 55 gal. per capita per day
Best places in Italy use is 15 to 20 gal. per capita per day.

In attempting to estimate future water consumption of a town or city, we must consider the following factors: 1. Increase in population 2. Economic status of the people 3.The tendency in U.S. for an average increase in consumption yearly of 1 gallon per capita per day.

B. Public Usage.
   1. Public uses other than domestic and industrial
      a. Fires
      b. Cleaning streets
      c. Cleaning away ice & snow in streets
      d. Swimming pools
      e. Public drinking fountains
      f. Ornamental fountains, lakes & pools
      g. Lawn watering in parks & public places
      h. Sprinkling roads
      i. Public toilets
      j. Public buildings & laboratories, heating etc.
      k. Flushing water lines, sewers
      l. Cleaning filter beds.

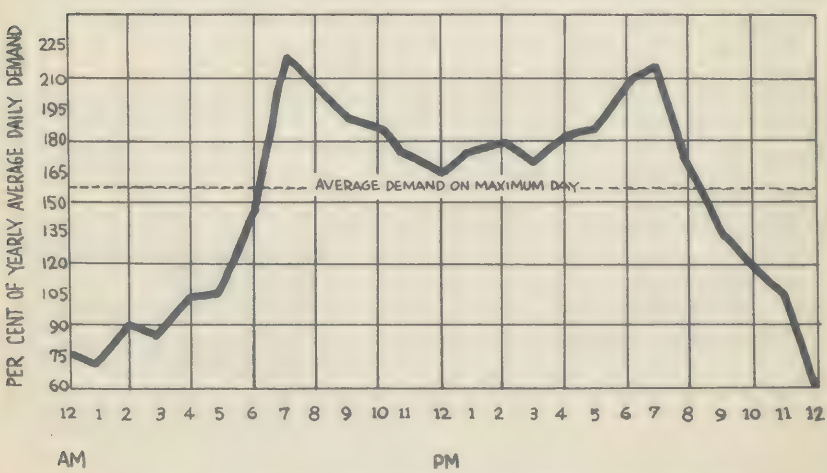
SEASONAL VARIATION IN WATER CONSUMPTION



MAXIMUM MONTHLY PUMPAGE VARIATION---- CLEVELAND

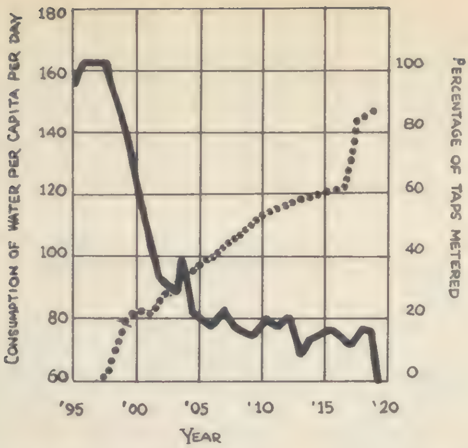
ENG. NEWS RECORD, 1921

HOURLY VARIATION IN WATER CONSUMPTION



HOURLY VARIATION OF PUMPING DEMAND ON MAXIMUM DAY ---- CLEVELAND

ENG. NEWS RECORD, 1921



THE EFFECT OF METERING UPON WATER CONSUMPTION. ——— GALLONS PER CAPITA PER DAY
DATA FOR PATTERSON, N.J. COMPILED BY CUDDEBACK. ••••••• PERCENTAGE OF TAPS METERED

2. Fire protection bureau requirements for storage and flow

Population	Flow	Period
1,000	1,000 G.P.M.	4 Hrs.
1,500	1,250 "	5 "
2,000	1,500 "	6 "
3,000	1,750 "	7 "
4,000	2,000 "	8 "
5,000	2,250 "	9 "
6,000	2,500 "	10 "
10,000	3,000 "	10 "
13,000	3,500 "	10 "
17,000	4,000 "	10 "
22,000	4,500 "	10 "
28,000	5,000 "	10 "
40,000	6,000 "	10 "
60,000	7,000 "	10 "
80,000	8,000 "	10 "
100,000	9,000 "	10 "
125,000	10,000 "	10 "
150,000	11,000 "	10 "
200,000*	12,000 "	10 "

* Over 200,000 population, 12,000 G.P.M., with 2,000-8,000 G.P.M. for an additional fire.

Storage - The above fire flow can be obtained from the source of supply and storages. In determining the total storage required, for the period listed, consideration must also be given to the daily city consumption in gallons per minute. For example, if a city has a 1,000 population, a well producing 200 g.p.m. and a city consumption of 100 g.p.m., the storage required would be:

Total Storage - (1000 + 100) - 200) x 4 x 60 = 216,000 gallons

The minimum size water main which will supply adequate protection in residential areas is 6 inch.

QUALITY.

A. The qualities of water which are important are:
1. Freedom from pathogenic micro-organisms
2. Freedom from chemical impurities affecting appearance, taste, odor, hardness or softness
3. Freedom from algae which are likely to cause taste and odors
4. Optimum content in minerals which are important in relation to deficiency diseases
5. Optimum content in minerals other than those related to deficiency diseases, such as produce poisoning
6. Optimum relation to those factors which prevent corrosion of water pipes and deterioration of water system.

B. The standard method of bacteriological examination of water technically requires that:

1. Less than 10% of the 10 c.c. portions that are examined shall show bacterial contamination by coliform group
2. Less than 5% of the standard samples that are examined shall show 3 out of 5 portions of any single sample to be contaminated by the coliform group when 20 or more samples have been examined, and no more than 1 sample to be so contaminated when less than 20 samples have been examined.

   This requirement actually means in practice that if they are observed, then the water supply will contain on an average of 1 or less coliform bacillus per 100 c.c. of water and that over a long period of time this will not vary above 10 coliform bacilli per 100 c.c. of water.

C. Water Quality Depends on

1. Origin and source (location, geology, population on watershed)
2. Treatment process of water
3. Distribution system

D. The final product should have the following qualifications in order to be potable

1. Bacterial content should be such as to conform with the requirements of the U. S. Treasury Drinking Water Standards
2. Turbidity should show less than 10 p.p.m. (parts per million) of particulate matter suspended in the water. Good filter plants produce water with about 1 p.p.m. of suspended matter
3. Color should show less than 20 p.p.m. of colored matter in solution. Good, apparently colorless, water has less than 5 p.p.m. of matter in solution. Discoloration of water does not mean that it is poor water.
4. Mineral content of water
   a. Lead should be less than .1 p.p.m.
   b. Copper should be less than .2 p.p.m. (this could probably be higher)
   c. Zinc should be less than 5.0 p.p.m. (this could probably be higher)
   d. Sulphate should be less than 250 p.p.m.
   e. Magnesum should be less than 100 p.p.m.
   f. Chlorides should be less than 250 p.p.m. Taste is objectionable above this concentration
   g. Iron should be less than .3 p.p.m. This is of industrial importance.
   h. Manganese should be less than .2 p.p.m. The lower the better for industry
   i. Fluorine should not be more than 1. p.p.m. and probably not less than .1 p.p.m.
   j. There are no standards for other elements
   k. Total solids should be less than 1,000 p.p.m. This could probably be higher
5. The CO_2 and the pH are variables depending upon such considerations as corrosion and hardness
6. Hardness is objectionable depending upon the geographical location, industry and customs, thus the water of

   New York has 50 p.p.m. of hardness
   Baltimore has 100 p.p.m. of hardness
   Indianopolis has 200 p.p.m. of hardness
   Rio Grande area has 350 p.p.m. of hardness

   There are two types of hardness -
   a. That due to carbonate salts
   b. That due to non-carbonate salts such as sulphates, nitrates and chlorides

   Hardness is generally due to calcium and magnesium salts. Generally, a reasonable hardness should not exceed 100 p.p.m. Water that is too soft usually becomes corrosive
7. Corrosion
   a. Chemical
      1) Oxygen: where interior surface of pipe has no protective coating, then the presence of oxygen in the water causes corrosion. The surface of the metal pipes is covered by a layer of hydrogen ions from the ionization of water. If an excess of oxygen is present in the water the hydrogen ions combine with the oxygen and the excess oxygen combines with the metal and oxidizes it.

      2) Carbon Dioxide: a pH below 8.2 usually aids corrosion, since this indicates the presence of bicarbonates which may ionize and release carbon dioxide which forms carbonic acid. This process depends on the total alkalinity of the water. A water having a low alkalinity needs a high pH in order that it be non-corrosive, and conversely, a water having a high alkalinity will be non-corrosive at a lower pH than a water having a low alkalinity. Alkalinity, as used here, refers to the total ionized and un-ionized potentially alkaline minerals that may be present in the water. These usually consist of bicarbonates, and sulphates of calcium, magnesium, and sodium. Carbonates and silicates of calcium and sodium in the water protects against corrosion by causing a thin film of carbonate or

silicate salts to protect the inner surface of the pipes, if the pH of the water is kept within the above mentioned limits. The presence of CO_2 in the water will result in a water that will tend to be corrosive. This is thought to be due to the dissolving of the iron as the ferrous bicarbonate which is subsequently oxidized by the oxygen present to form ferric hydroxide, the familiar red-brown, rust-like precipitate.

b. Electrolytic
Electric car lines produce a current of electricity in the ground which may cause corrosion.

c. Galvanic
Pipe lines composed of dissimilar materials may cause corrosion due to the electric current produced by the difference in electric potential between the two materials.

8. High chloride and nitrate content indicates past pollution of the water. Chlorides frequently indicate sewage pollution. Free ammonia and albuminoid ammonia indicate the amount of nitrogenous organic matter in the water. Nitrites indicate the amount of nitrogenous organic matter in the water. Nitrites indicate organic matter undergoing bacterial oxidation. Nitrates indicate that organic pollution has been completely mineralized.
9. Odors in water may be due to putrifaction of organic matter. The most objectionable odors developed in surface water are caused by the growth and decay of algae, diatoms, protozoa, and other microscopic organisms. Industrial wastes sometimes cause odors in water.
10. Special Problems

a. Boiler feed waters must be of strict specification.
Should not have more than .03 p.p.m. of dissolved O_2
" " " " " .05 p.p.m. of aluminum
" " " " " 5.00 p.p.m. of silica
" " " " " a total hardness of more than 8.0 p.p.m.

b. Carbonated beverages can have a water whose alkalinity can go up to 100 p.p.m.
whose iron & manganese can go up to 0.2 p.p.m.
aluminum can go up to 0.2 p.p.m.
pH must go no lower than 3.5 p.p.m.

c. In the rayon industry the water may have a total hardness of not more than 8.0 p.p.m.
iron & manganese of not more than 0.03 p.p.m.
total solids of not more than 40.0 p.p.m.

RESERVOIRS

Unless the minimum daily flow of a stream is well above the maximum daily draft which must be satisfied in a water supply project, the yield of the drainage area must be increased by the construction of an impounding reservoir. This has two functions:

1. To store up the stream flow during the winter and spring months so that it will be available in the periods of low flow.
2. To store water during normally wet years to make up for the lower flow of the dry years.

The maximum size of a reservoir is about 5% of the drainage area. The possibility of large leakage from the reservoir must be carefully considered in choosing the site. If the leakage is too great more favorable sites must be chosen. The evaporation loss must be considered in constructing a well.

Common law gives rights to use of water for down stream owners of land. To prevent law suits, the water rights of the stream should be bought, or a predetermined amount of water should be allowed to pass by at all times. The history of the water yield of a stream or streams should be known over a longer period of time (perhaps 20 years) in order to have adequate data as to the feasibility of a reservoir project.

Many dams made in construction of a reservoir are of earth. Failures of earth dams have occurred due to flood flows overtopping the dam and cutting it away. The quick release of the impounded water in such cases may cause heavy economic damage and loss of life. Consequently, spillways must be designed with extreme flood conditions in mind. The flood characteristics of a stream should be studied by -

1. Gauge records in the past
2. Examination of evidence of past high stages of stream if gauges are unavailable
3. Examination of drainage area characteristics.

Silt-bearing water may deposit so much mud in reservoirs that the accumulations will, in time, seriously impair their usefulness by decreasing the available capacity and increasing evaporation because of lesser depth of the water. This occurs where soil is easily erodible and it is aggravated by deforestation or mine works. Methods of dealing with silting

problem include: (1) Reforestation of hill sides in erosin areas. (2) Construction of small soil saving dams in gullies. (3) Wasting or by-passing flood flows carrying much silt. (4) Suction dredging and dragline excavations. (5) Emptying reservoir in winter and removing silt with teams.

The sanitation of reservoir water-shed and reservoir should depend on the amount of treatment given to the water. Where reservoir water is directly consumed untreated, no recreational use of reservoir should be allowed, and the use of the water shed should be strongly discouraged. If water is chlorinated, less vigilance is necessary. Where a complete treatment plant is in use and properly operated, it would appear that the only objection of using the reservoir for bathing, fishing, etc., would be an aesthetic one. The best policy, of course, is to discourage use of reservoir for recreation if other bodies of water are available.

TREATMENT.

A. Impounding or Plain Settling. This method gives an even source of water to draw from during all seasons. During the period of impounding sedimentation of particulate matter and self-destruction of bacteria takes place, and also a dilution of minerals by mixing of waters which are at one time high in mineral value and at another time low in mineral values. Thirty days of impounding will usually reduce the bacterial count by 95 to 98%. In New England, in many instances, the only treatment of water is by impounding, but this method alone should not be trusted. Such water should be chlorinated.

   High Temperature. Low flow and high reservoir deficiency (decreased amount of water stored) cause an inordinate increase in the manganese content of the water.

B. Artificial Settling. By this method, smaller capacity reservoirs are used than by the impounding reservoir. The water here is held for 12 to 48 hours before being released for further treatment.

C. Chemical Treatment. Coagulation and Settling. Aluminum Sulphate, $AI_2\ (SO_4)_3$ is usually used for this treatment. Iron sulphate, and iron chloride can also be used. By this method the alum reacts with the carbonates and bi-carbonates in the water to form aluminum hydroxide, $AI\ (OH)_3$ precipitate and other complicated salts. The precipitate enmeshes bacteria and other small particles suspended in the water and pulls them down while settling. This process of settling also helps to regulate discolored water by chemical and physical action. The amount of alum used depends upon amount of turbidity in water. The dosage of alum in water is .5 to 4 grains per gallon. The optimum pH for precipitate or flocculation is between 6.6 and 6.8.

   In Louisiana, experience has shown that coagulation is better obtained with iron sulphate than with alum, that is, $AI_2\ (SO_4)_3$. This is due to the fact that most surface waters in Louisiana have a pH between 7.6 and 7.8. Iron sulphate reacts better at this higher pH than does alum.

   When lime is used in softening water, the pH becomes higher and therefore if a chemical is used for coagulation purposes, then the iron sulphate gives the best results.

   When the water contains much manganese, it is best to use an iron coagulant and the pH of the media should be 8.0 to 8.4 in order for suspension to be most readily flocculated.

D. Slow and Rapid Filters.
   1. Rapid Filter
      a. Rate of water filtered is 125 million gallons per acre per day
      b. Size of sand grains used is .45 to .60 millimeter
      c. Cost of a plant to filter a million gallons of water is 25-35,000 dollars.
   2. Slow Filter
      a. Rate of water filtered is 1.5 to 3 million gallons per acre per day
      b. Size of sand grain used is .25 to .30 millimeter
      c. Cost of a plant to filter a million gallons of water is 30-50,000 dollars.
   3. Comparison of Slow and Rapid Filters
      a. The slow filter requires less skilled operation
      b. Operating costs are generally lower with slow filter, though gallon for gallon in many instances the cost is about equal. The rapid filter is cheap and efficient for American types of water.
      c. The slow filter uses less wash water
      d. The over-all bacterial efficiencies of the two types of plants are the same.
      e. The rapid filter will treat more turbid water and is more efficient in color

removal.

f. The rapid filter has greater flexibility in operation because of its use of chemical pretreatment, the fact that there is less interruption to service while cleaning beds, and the greater number of units.

g. Including cost of land, the rapid filter is generally lower in first cost.

E. Disinfection

1. Ca $(OCL)_2$ or bleaching powder (calcium hypochlorite) gives somewhat less than 30% free chlorine. It rapidly loses its available chlorine on standing.
2. H.T.H. (High Test Hypochlorite) gives 60-80% free chlorine
3. Liquid chlorine is most important, most efficient and most stable of disinfectants
4. Other halogens are useful. Iodine is sometimes used, but is not efficient. Bromide is seldom if ever used.
5. Ultra-violet irradiation is very costly, very inefficient. The rays do not penetrate well into a cloudy water The mechanical and electrical difficulties of this method are great.
6. Ozone (O_3) has not proved useful due to expense, production, efficiency, odor and taste.
7. Silver disinfectants are expensive and unreliable. They are difficult to control.
8. Halazone is an organic chlorine compound whose usefulness appears to be gaining favor. It is a chloramine produced by mixing benzoic acid with chloramine-T.

Emergency sterilization of drinking water can be accomplished by:

1. Adding 2 drops of tincture of iodine to each quart of water. Mix - and allow to stand for ½ hour.
2. Adding 1 teaspoonful of chlorinated lime to 1 quart of water and mix well. Use one teaspoonful of this solution to each 2 gallons of water to be used for drinking, and allow to stand for 30 minutes.

F. Algae

1. The number and type of algae should be determined.
2. The algae growth curve follows the solar radiation curve, i.e., the greater the radiation, the greater the growth, and vice versa, therefore eliminating sunlight prevents growth and algae.
3. Temperature is one of the important factors in determining the type of algae present and influences the numbers present. Each type of algae takes a different dosage of copper sulphate for its control. Knowing the mean temperature will more or less indicate the types of algae to expect.
4. Copper sulphate $(CU\ SO_4)$ is most useful to control growth of algae. It is a toxic agent to algae. Dosage is .1 to 1 p.p.m. The dose depends on the type and number of algae and also on the number of fish in the water. The average dose is .25 to .3 p.p.m. put into the impounding reservoir. Chlorine is not as effective as copper sulphate. Larger doses than 1 p.p.m. produce discoloration of materials by the precipitation of the copper sulphate.
5. Chlorine prevents algae from growing and developing. Superchlorination is used to destroy taste and odor caused by algae.

G. Corrosion

1. To prevent corrosion, the acidity of water must be kept low and the pH not less than 8.2
2. Water must be kept in chemical balance to calcium carbonate. Water that is supersaturated with calcium carbonate will quickly deposit a coating on the inside of the pipe, and thus prevent the water from dissolving the iron. Water that is undersaturated with $CaCO_3$ will dissolve the $CaCO_3$ film already formed on the pipe. Care must be taken that a chemical balance is maintained so that the film does not become too thick (thus clogging the pipe), and so that the film is not dissolved away (thus allowing corrosion).
   Calcium carbonate can be built up to saturation (25 or 30 parts per million) by adding lime to the water. The pH can be built up by adding soda ash (sodium carbonate) to give a slight pinkish color to water containing phenolphthalein.
3. Pipe surfaces can be lined with bitrimastic enamel and coal tar products.
4. Copper pipes are better than galvanized iron or other iron pipes. Pipe lines composed of pipes of dissimilar metal should be avoided.
5. Water should not be allowed to become too soft.
6. Stray currents which cause electrolytic corrosion should be prevented from entering water mains.

H. Hardness and Softening of Water. Since hardness is due to either carbonate and non-carbonate compounds, the treatment would be as follows:

1. For carbonate hardness quick-lime (CaO) or slaked lime $(Ca(OH)_2)$ is added to the water which will precipitate out calcium carbonate $(CaCO_3)$ $Ca(HCO_3)_2$ plus $Ca(OH)_2$

$\longrightarrow \downarrow 2\ Ca\ CO_3$ Plus $2H_2O$.

The hardness of water is always expressed in terms of $CaCO_3$, therefore all calcium and magnesium salts which cause hardness are reduced to terms of $Ca\ Co_3$.

The amount of lime added is calculated in terms of unslaked lime (CaO), therefore the molecular weight of slaked lime ($Ca(OH)_2$) is expressed in terms of CaO. One grain of CaO per U. S. gallon = 17.1 parts per million = 143 pounds per million gallons. Since the molecular weight of $Ca\ CO_3$ = 100, and that of CaO = 56, then 17.1 p.p.m. x 100/56 = 31 p.p.m. of $Ca\ CO_3$ as hardness precipitated by one grain of CaO per gallon. Or, 100 p.p.m. $CaCO_3$ will require 3.2 grains of CaO per gallon = 458 pounds per million gallons.

2. For non-carbonate hardness, sodium carbonate ($NaCO_3$) is added to the water which will precipitate out calcium carbonate. Thus when hardness is due to calcium sulphate ($CaSO_4$), the treatment is as follows: $CaSO_4$ plus $Na_2\ CO_3 \longrightarrow \downarrow CaCO_3$ plus $Na_2\ SO_4$.

   A similar reaction occurs when chlorides are precipitated.

   1 grain of $Na\ CO_3$ per U. S. gallon = 17.1 p.p.m. = 143 pounds per million gallons. Since the molecular weight of $Na\ CO_3$ is 106, and that of $Ca\ CO_3$ is 100, then 17.1 p.p.m. X 100/106 = 16 p.p.m. of $Ca\ CO_3$ present as $Ca\ SO_4$ will be precipitated by 1 grain of $Na_2\ CO_3$ per gallon. Or, 100 p.p.m. will require 6.4 grains of $Na_2\ CO_3$ per gallon = 915 pounds per million gallons.

I. Softening Water with a Zeolite. This is an efficient and automatic method useful for softening water on a small or large scale. Zeolites have the property of exchanging the sodium base which they contain for other bases brought into contact with them. They exist naturally in certain soils, where they play the important role of holding potassium and other alkaline bases in the soil, thus preventing their being washed away with the rain water. Synthetic zeolites such as Permutit are now found upon the market.
   There are 3 types of Zeolites.
   1. Sodium Zeolite. This can be used for waters containing calcium and magnesium salts of the carbonate, bicarbonate, sulphate and chloride type. Calcium and magnesium zeolite will be precipitated out and sodium salts of carbonate, sulphate and chloride type will remain in solution. Sodium zeolite is the most generally one used. The zeolite can be regenerated from the precipitate by adding sodium chloride (NaCL) solution to it.
   2. Hydrogen Zeolite. This can be used for water containing calcium, magnesium and sodium salts of carbonate, bicarbonates, sulphate, and chloride type. Ca, Mg and Na zeolite is precipitated out leaving carbonic acid (H_2CO_3), sulphuric acid (H_2SO_4) and hydrochloric and (HCL). Hydrogen zeolite can be used to soften sea water. This zeolite can also be regenerated.
   3. Magnesium Zeolite. This can be used for waters containing calcium salts of the carbonate, bicarbonate, sulphate and chloride types. Calcium zeolite is precipitated out and magnesium carbonate, sulphate and chloride is left in solution. This zeolite can also be regenerated.

      These operations cost 40 to 50 dollars per 1,000,000 gal. of water. Each one has a special application. Sometimes all 3 are needed for softening certain waters.

AERATION.

Aeration of water has a number of useful functions. It readily removes hydrogen sulfide and the odors caused by decomposed organic matters. Odors caused by microscopic organisms can be greatly reduced. Simple chlorine odor can be removed, but chlorine combination odors are only slightly affected. Carbon dioxide can be removed to the extent of 70 percent or more, and corrosiveness caused by carbon dioxide will be remedied to some degree. Aeration is primarily considered as a physical or mechanical action by which the undesirable matters are swept out of the water and replaced with oxygen and other gases of the air. It is also used in removal of iron and manganese, in which case the oxygen made available unites chemically to oxidize and precipitate the bicarbonate or hydroxide of the metals. It is also used for mixing chemicals with water, as in the Aeromix process and in the use of diffused compressed air. The aeration methods used depend upon the material to be removed, efficiency desired, and local conditions as to head, etc. The various aeration methods are as follows:

1. Spray Nozzles. These are most efficient but require considerable head. They break up the water into a fine spray and will reduce carbon dioxide by 90 per cent or more. They are usually operated at heads of 10 to 20 lb. per square inch. The amount of water discharged per nozzle will depend upon nozzle design and head used. A nozzle of good design having a 1 inch orifice will discharge 72 gal. per minute to a height of 7 feet at a 10 lb. pressure.
2. Cascades. A simple cascade consists of a flight of three or four concrete or metal steps over which the water tumbles in a thin sheet. This type is frequently used

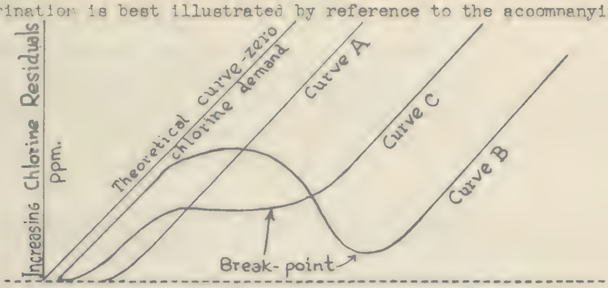
as a first step in treatment of lake and reservoir water. In summer it often is unable to reduce adequately stagnant or musty tastes and odors and those caused by algae. A more efficient cascade can be improvised for small supplies by discharging the water from a perforated pipe down through a series of trays or screens of 1/8 inch mesh screen cloth. The trays should be about 1.5 ft. apart.

3. Trays. Tray aeration with subsequent filtration through coke beds finds its greatest use in iron and magnesium removal plants. Plain tray aeration without contact media is also used.
4. Trickling Beds. These consist of beds of coke, slag, or stone about 2 ft. thick supported by bronze screens. Three beds about 1.5 ft. apart are generally used. The water is applied from a perforated pipe or pipes placed above the top bed and trickles down over the coke or other material. The beds are more efficient than the cascade but less so than the sprays. Although they will remove about 75 per cent of carbon dioxide when operated at about 60 gal. per minute per square foot, they are generally used for iron removal at considerably lower rates.
5. Air Diffusion. This is accomplished by blowing compressed air through porous plates in a manner similar to that used in treating sewage. The plates may be so placed as to set up a spiral flow which will mix chemicals as well as aerate. The Aeromix is a patented apparatus which employs a draft pipe through which the water passes and by its suction draws in air through a number of small tubes. Vanes in the draft pipe also set up a spiral motion to bring the bubbles into intimate contact with the water. After leaving the draft pipe, the bubbles escape to the atmosphere. Aeration and mixing of chemicals can be combined. Both these methods will reduce hydrogen sulfide and other odors, oxidize iron and manganese, and give thorough mixing of chemicals.
6. Paddle wheel aerators are sometimes used. This type and diffused-air type are generally "after developments", added to the plant when difficulties arise.

BREAK-POINT CHLORINATION

Break-point chlorination is a recent development in water supply treatment, which has been very successful in removing objectionable tastes and odors. In the past, it was found that tastes and odors in raw waters were frequently intensified at high chlorine residuals, but were greatly reduced or disappeared entirely when additional chlorine was added. This discovery led to the development of a chlorination process now referred to as Break-point Chlorination.

Break-point chlorination is best illustrated by reference to the accompanying curves.



Typical chlorine residual curves obtained when water is treated with increasing amounts of chlorine. (Courtesy of Wallace & Tiernan Co.)

Curve A is representative of a clear water, free from organic matter and free ammonia, in which no pronounced break-point can be obtained.

Curve C is typical of waters containing only slight amounts of organic material and very little free ammonia. Here the break-point is not pronounced, but its presence is plainly indicated by the flat part of the curve.

Curve B illustrates a definite break-point such as will be obtained with polluted waters containing appreciable amounts of free ammonia and nitrogen in other forms.

The magnitude of the chlorine residual curve or its shape is seldom the same in different waters, or in the same water at different times. When waters contain varying amounts of industrial wastes, biological growths or domestic wastes, the break-point may be expected to occur at varying rates of chlorine application.

COLLECTION OF SAMPLES FOR BACTERIOLOGICAL ANALYSIS

1. Bottle and stopper must be sterile. These are usually furnished by the Health Department.
2. Capacity of bottle must be not less than 4 ounces.
3. Faucet must be flamed with an alcohol lamp or paper torch before obtaining sample.
4. Let water run for at least 1 minute before taking sample. When it is not possible to flame the tap, the water should be allowed to run for 5 minutes before sampling.
5. When stopper is removed from sample bottle, care must be taken not to touch the bottom of stopper or sides of opening of the bottle. The technique is as follows: The Health Department usually furnishes sterilized bottles covered with paper to protect against contamination. As a further precaution to prevent finger contamination, the stoppers and necks are covered with tinfoil. To use the bottle, the tinfoil is loosened from the edges but not removed from the stopper, care being taken to keep it intact. When it is loosened properly, it will form an umbrella-like protection for the stopper. When stopper is removed, it should be kept in the same position as in the bottle, head up, and held in one hand while the bottle is held in the other hand and quickly filled up to the beginning of neck of bottle, with water to be examined. The stopper should then be replaced firmly and the tinfoil rearranged as originally found.
6. Sample from reservoir, pond, or stream is taken by submerging the bottle with a sweeping forward motion, so that no water that has touched the hand will enter the bottle, the stopper having been previously removed as directed. In collecting from a well, the pump should be worked to get rid of standing pipe water before taking sample; if a bucket is used it should be filled 2 or 3 times and contents discarded before drawing for the sample.
7. Bottles should be placed in ice containers and shipped to laboratory immediately. The shipment should be timed so as to obviate delays in transit and avoid delivery at laboratory on Saturday. The large metal container bottle must be shipped by express, and the single bottle mailing container by parcel post. All charges must be prepaid.
8. If the intervening time between collection and reaching laboratory is not more than several hours, icing may not be necessary.
9. Water sample should be labeled. It should show source of water, date of collection, name of collector.
10. Water survey sheet should be filled out completely.

PHYSICAL AND CHEMICAL TESTS FOR WATER SUPPLIES (7)

Turbidity Test. For turbidities under 100 parts per million, comparison with prepared standards is recommended. For turbidities between 100 and 1000 p.p.m., the candle turbidimeter is used. This consists of a graduated glass tube and a support so constructed as to hold the glass tube over a "standard candle". The water to be tested is poured into the glass tube until the image of the candle flame just disappears from view. The turbidity of the water will be indicated by the scale reading corresponding to the elevation of the water in the tube.

For turbidities over 1000 p.p.m., the sample is diluted with turbidity-free water until the resultant turbidity is less than 100, then tested as above and a corrected reading computed.

Color Test. The color of a sample is observed by filling a Nessler tube to the 50 milliliter mark with the water to be examined. The intensity of the color of the water in this tube is then compared with the various color standards. This is done by looking down through the tube at a white surface until a standard is found which has the same color as the sample. When the color of the sample is between that of two standards, the color can be estimated. An alternate method for determining color is by the use of standard color discs in a colorimeter or color comparing apparatus.

Alkalinity Test. There are several methods of doing this test, but the most common is probably the one using phenolphthalein. The procedure is as follows: (1) Add 5 drops of phenolphthalein indicator solution to 100 milliliters of water in a flask. If the solution becomes pink colored, alkalinity due to hydroxides or normal carbonates or both are present in the water. (2.) Add standard acid solution (n/50 or 1/50 sulfuric acid) from a burette slowly and in small amounts until the solution becomes colorless. Multiply the number of milliliters of one fiftieth normal acid used by 10, and denote the result as "phenolphthalein alkalinity". The result is expressed as parts per million.

In cases where the water is quite alkaline, it is permissible to use 50 milliliters of water and then multiply the number of milliliters of acid solution used by 20 to obtain result in parts per million. The results in all cases as described refer to alkalinity

expressed in terms of calcium carbonate.

At water treatment plants where water is softened, it is advisable also to run the methyl orange alkalinity test. Much information concerning the character of water may be gained by comparing the results obtained by these two indicators. Examples:

If the phenolphthalein alkalinity is zero, and methyl orange alkalinity is 40, then there are 40 p.p.m. of bicarbonate, but no hydroxides and no carbonates.

If the phenolphthalein alkalinity is less than 1/2 the methyl orange alkalinity, then normal carbonate, expressed in terms of calcium carbonate is equal to twice the phenolphthalein alkalinity; bicarbonate present is equal to the methyl blue alkalinity minus the calcium carbonate; and hydroxides are equal to zero.

If the phenolphthalein alkalinity is exactly 1/2 the methyl orange alkalinity, then normal carbonate, expressed in terms of calcium carbonate is equal to twice the phenolphthalein alkalinity; bicarbonates and hydroxides are zero.

If the phenolphthalein alkalinity is greater than 1/2 the methyl orange alkalinity, the normal carbonate is equal to twice the difference between the methyl orange alkalinity and the phenolphthalein alkalinity, and the alkalinity due to hydroxides is is equal to twice the phenolphthalein alkalinity less the total alkalinity. Bicarbonate is equal to zero.

If the phenolphthalein alkalinity equals the methyl orange alkalinity, then only hydroxide is present, that is, if each test shows an alkalinity of 50 p.p.m. then the hydroxide present is 50 p.p.m.

Table summarizing above relations between phenolphthalein alkalinity and methyl orange alkalinity. (P stands for phenolphthalein alkalinity in parts per million and T stands for methyl orange alkalinity in parts per million).

When P is zero, then hydroxide is zero, carbonate is zero, and bicarbonate is equal to T.
When P is less than $\frac{1}{2}$ T, then hydroxide is zero, carbonate is 2 P, and bicarbonate is equal to T-2 P.
When P is equal to $\frac{1}{2}$ T, then hydroxide is zero, carbonate is 2 P, and bicarbonate is equal to zero.
When P is greater than $\frac{1}{2}$ T, then hydroxide is 2 P-T, carbonate is 2 (T-P), and bicarbonate is equal to zero.
When P is equal to T, then hydroxide is T, carbonate is zero, and bicarbonate is equal to zero.

The procedure for the methyl orange test is as follows:

1. Fill the burette with standard sulfuric acid solution to a point near the zero. Open stop-cock slightly and allow solution to flow through in order to remove all air bubbles from tip.
2. Measure exactly 100 milliliters of water to be tested and pour into flask.
3. Add 2 drops of methyl orange indicator to water and shake to mix the two. If water is alkaline, the color of mixture will be yellow. If the mixture is red, the water has an acid reaction. If the mixture has a yellow tint, proceed with the alkalinity test.
4. Record the level of the standard solution in this burette. Place a sheet of white paper or milk glass under flask so that the color of the indicator in the sample under examination can be more clearly determined. Let small portions of the standard acid solution drop into the sample of water in the flask and shake after each addition. As soon as the water takes on a pinkish tinge, stop adding acid and read level of acid in burette. The difference between the two burette readings in milliliters and acid multiplied by 10 will give result in parts per million.

Since the alkalinity of natural water is mostly due to the presence in solution of carbonates, bicarbonates and hydroxides of various elements such as sodium, potassium, calcium, maganesium, and iron, the above tests will indicate which are present and in what quantities.

Alkalinity is an important determination to the water treatment plant operator because the action of the coagulants used to clarify water and prepare it for filtration requires sufficient alkalinity to insure a proper reaction. Conversely, an excessive alkalinity may also interfere with the reaction. Caustic alkalinity, which is not found in nature, is found in waters overtreated with lime by accident or design.

Free Carbon-Dioxide. The presence of this gas in water leads to the corrosion of pipes, particularly steam and hot water pipes, and to the solution of any lime salts with which the water may come in contact. The determination of CO_2 is of some value, therefore, in determining the corrosive properties of water and also in ascertaining the type of alkalinity

existing in the water. Procedure for test is as follows:

1. Place 100 milliliters of the water to be tested in the Nessler tube immediately before the test is made.
2. Add about 10 drops of phenolphthalein solution to the water. If the water contains CO_2, no color will be produced when the indicator is added.
3. Add sodium hydroxide solution slowly from burette, mixing thoroughly by rotary movement of tube after each addition. Stop adding sodium hydroxide when a faint pink color persists throughout water in tube. Measure the amount of standard sodium hydroxide solution [(N)44 or 1/44 normal solution] used by reading the burette before and after determinations. The number of milliliters used multiplied by 10 equals the parts per million of free carbon dioxide. To convert CO_2 in parts per million to terms of calcium carbonate in parts per million multiply by 2.272.

Total Hardness. The determination of hardness by the soap method roughly approximates the amount of calcium and magnesium in a water, though it actually measures the soap-consuming power of the water. The latter value, however, is of great economic importance and the test may be utilized in the control of the smaller water softening plants, or in testing various waters for hardness. Procedure for test is as follows:

1. Place 50 milliliters of the water to be tested in a 250 milliliter bottle. Add the standard soap solution to the sample from the burette in 0.2 or 0.3 milliliter portions.
2. Shake the bottle vigorously after each addition of the soap solution continuing this process until a lather remains on the surface of the sample for 5 minutes with the bottle lying on its side.
3. Near the end of the test, it is well to add the soap solution 2 or [illegible] drops at a time.

The number of milliliters of soap solution used is measured from the difference between the before and after readings on the burette. A "blank" should be run in the same manner, using 50 milliliters of distilled water. This determines the amount of soap necessary to produce the lather itself, and this amount (usually from 0.5 to 1.0 milliliters) is subtracted from the amount used in the test on the water sample. The number of milliliters of soap solution used in the test, multiplied by 20 gives the total hardness in parts per million as calcium carbonate.

Non-carbonate Hardness. The permanent or "encrusting hardness" of a water in which the total hardness is greater than the alkalinity, may be calculated roughly by subtracting the total alkalinity obtained (when using methyl orange indicator) from the total hardness. The result is noted as parts per million expressed in terms of calcium carbonate. Non-carbonate hardness is caused by sulfates and chlorides of calcium and magnesium. The chlorides of magnesium and calcium are very corrosive to steam boilers and quickly cause pitting and grooving of boiler tubes. Sulfates of calcium and magnesium also cause scales in boilers.

Although the common sodium compounds do not cause hardness, the carbonates and bicarbonates in steam boilers will release CO_2 and cause corrosion of the tubes. Sodium sulfate may cause foaming in boilers if present in large amounts.

Hydrogen-ion Concentration or pH. The hydrogen ion concentration in water is an expression of the intensity factor of acid or alkaline properties as opposed to the quantity factors "acidity" and "alkalinity", that is, the former measures the quality of intensity of acids and alkalies, the latter measures the amount of acid or alkali material present. The test in its simplest form is made by taking a quantity of water to be tested, adding the proper indicator, and comparing the color produced with either a standard color in another sealed tube, or in some cases, glass disks are used.

Suggested pH Indicators for Use in Water Plants

Indicators	pH Range	Color Change
Methyl red	4.4 to 6.0	red to yellow
Brown thymol blue	6.0 to 7.6	yellow to blue
Phenol red	6.8 to 8.4	yellow to red
Thymol blue	8.0 to 9.6	yellow to blue
Phenophthalein	8.6 to 10.2	pink to red

All of the above tests for waters are made on both raw and treated waters.

Orthotolidin Test for Available Chlorine in Water. This test will measure slight excess amounts of chlorine. The orthotolidin solution is made up by dissolving 1 gram of chemically pure orthotolidin in 1 liter of 1% hydrochloric acid. Add 10 drops of the testing solution to a 1 ounce bottle of the water to be tested. If the water changes to a lemon-yellow color, it indicates a slight excess of chlorine over and above the amount necessary to satisfy organic and bactericidal demands without the formation of tastes and odors. No color indicates insufficient chlorine and if an orange-yellow hue results, the water is being

overdosed and the amount of chlorine applied may be reduced. To make certain that the chlorine has completed its work, 10 minutes should be allowed to elapse after the chlorine has been added to the water before the test is made.

Chloramine reacts with orthotolidin in the same way as chlorine. In alkaline waters, the orthotolidin test may result in blue color. Doubling the amount of orthotolidin solution used in making the test will bring about the normal yellow color.

Colorimeter apparatus may be used to determine the quantity of active chlorine in solution.

WATER SUPPLIES--REGULATIONS OF LOUISIANA SANITARY CODE

Definitions: For the purposes of this code, the following definitions shall apply:-

A public water supply is a water which is available for drinking, culinary and ablutionary use by the public, by transients, or by persons other than the immediate family of the owner of the supply.

A ground water supply is one derived from underground sources such as springs, wells or infiltration systems.

A surface water supply is one derived from sources on the service of the earth such as streams, ponds, lakes, or reservoirs.

General. (1) Every drinking, culinary, and ablutionary water supply which is hereafter constructed, or extensively reconstructed, or every existing water supply which, in the opinion of the State or Local health officer, is unsafe, shall be made to comply with the requirements of this Code. (2) No public water supply serving more than one hundred persons shall hereafter be constructed or materially altered without the approval of plans and specifications by the State Department of Health and without a written permit from said Department. Plans and specifications shall be submitted in duplicate. (3) No public water supply serving less than one hundred persons shall hereafter be constructed, or materially altered, without the approval of the local health department. All construction shall take place in accordance with the plans as approved by the State Department of Health.

Water supplied for drinking or culinary purposes shall be - (1) Obtained from a source free from pollution; or (2) Obtained from a source adequately protected by natural agencies from the effects of pollution; or (3) Adequately protected by artificial treatment.

Water supplied for drinking and culinary purposes shall be: Safe and shall be clear, odorless, colorless, not unpleasant to the taste; shall not contain excessive amounts of soluble mineral water nor of the chemicals used in treatment; when necessary a water supply should be treated to remove objectionable characteristics.

Ground Water Supplies. All ground water supplies shall comply with the following requirements:

Exclusion of Surface Water from Site. The site within a safe horizontal distance of the source in all directions shall not be subject to flooding and shall be so graded and drained as to facilitate the rapid removal of surface water.

Satisfactory Earth Formations Above the Water-Bearing Stratum. The earth formations above the water bearing stratum shall be of such character and depth as to exclude contamination of the source of supply by seepage from the surface of the ground.

Distances to Sources of Contamination. Every ground water supply and all appurtenances thereto shall be located at a safe distance from all sources of contamination such as privies,cesspools, septic tanks, sub-surfaces tile systems, sewers, drains, barnyards, and pits below the ground surface. The horizontal distance from any such possible source of pollution shall be as great as possible, but in no case less than fifty (50') feet, except as provided under the following paragraph, or except as otherwise approved by the state or local health officer. If bacteriological examinations or other evidence indicate actual or potential pollution, the distance shall be increased or the location of the water supply changed, as may be required by the health officer.

Sewerage Near Wells or Springs. No floor drain, soil pipe, main drain, or other pipe which is directly connected to a storm or sanitary sewer, or through which water or sewerage from any source may back up, shall be located nearer than thirty (30') feet to any well, spring, or other source of water supply. All pipes and drains or parts thereof through which sewage or waste water flows, or into which sewage or waste water may back up, which are located within fifty (50') feet of any such water supply shall be constructed of extra heavy cast-iron soil pipe or cast-iron water pipe with leaded joints, or be of equivalent construction approved by the health officer.

Leakage from Toilets and Sewers. No toilet, sewer, soil pipe, or drain shall be located over, or where leakage therefrom, can reach any water storage basin, reservoir, source of water supply, or pump room.

Pits Near Water Supply. There shall be no pits or unfilled space below level of ground surfaces, or any part of which is within fifty (50') feet of such water supply, except properly constructed well, pump, or valve pits as covered under paragraph headed "Well, pump,valve, and pipe pits".

Minimum Depth of Casings and Curbings. All well and spring basin casings or curbings shall extend a safe distance below the ground surface. In no case shall the water be drawn from less than a depth of ten (10') feet.

Well Casing or Lining. Except from driven wells, all that part of the suction pipe or drop pipe of any well within ten (10') feet of and below the ground surface, and preferably within (20') twenty feet, shall be surrounded by a water-tight casing pipe extending above the ground, platform, or floor surface as the case may be, and covered at the top, as herein provided. In case of driven wells, the top of the driver pipe shall extend above the ground, platform, or floor surface. If a well has a lower casing extending below the upper, outer casing previously mentioned, there shall be a water-tight joint between upper and lower casing. The annular space between outer casings and well hole shall be tightly filled with concrete, impervious clay, or equivalent material.

Provided, That a dug well, in place of such casing pipe may be provided with a substantial water-tight lining of concrete, or of vitrified tile with outer concrete lining six (6") inches thick, or other suitable material. Such lining shall extend down for a distance of at least ten (10') feet, below the natural surface of the ground, and shall extend up to the well platform or pump room floor with a water-tight connection. In such case the platform or floor shall have a suitable sleeve pipe surrounding the suction pipe or drop pipe and projecting above as herein provided for a casing pipe. With the approval of State health authorities, the impervious lining of dug wells in any instance may be of lesser depth.

Cover of Floors. Every dug well, spring, or other structure used as a source of water, or for the storage of water, shall be provided with a water-tight cover. Covers and every pump floor shall be constructed of concrete or similarly impervious material and shall be elevated above the adjacent ground level and sloped to facilitate the rapid removal of water so as to provide proper drainage from the cover or floor and prevent contamination of the water supply. Such cover or floor shall be constructed so that there are no copings, parapets, or other features which may prevent proper drainage, or by which water can be held on the cover. In wells with pipe casings the casings shall project at least six (6") inches above ground level or the top of this cover or floor, and the cover or floor shall slope away from the well casing or suction pipe in all directions. Dug well linings shall extend at least six (6") inches above the ground surface and cover installed thereon. The cover shall be watertight, and its edges shall overlap and extend downward at least two (2")inches over the walls or curbings of such walls. If concrete is used, the floors, or cover slab shall be of portland cement concrete of such thickness and so reinforced as to carry the load which may be imposed upon it; - but in no case less than four (4") inches thick.

Well Seals and Covers. Every drilled well shall be provided with a water-tight seal or overlapping cover at the top of the casing or pipe sleeve.

Well Vents. Well vents shall be so constructed and installed to prevent the entrance of contamination.

Construction and Installation of Pumps. All water pumps shall be so constructed and installed as to prevent contamination of the water supply.

Handpump Head and Base. Every hand-operated pump shall have the pump head closed by a stuffing box or other suitable device to exclude contamination from the water chamber. The pump base shall be of solid one-piece recessed type of sufficient diameter and depth to admit the well casing as hereinafter provided. The top of the casing or sleeve of every well, equipped with such a pump, shall project into the base of the pump at least one (1") inch above the bottom thereof and shall extend six (6") inches above the level of the platform, well cover, or pump room floor on which the pump rests. The pump shall be fastened to the casing or sleeve.

Power-Pump Base. Where power pumps or pump motors are placed directly over the well, the pump or water support, shall have a solid, water-tight metal base without openings, to form a cover for the well, recessed to admit the well casing. The well casing shall project into the base at least one (1") inch above the bottom thereof, and at least one (1")

above the level of the foundation on which the pump rests, which in turn shall be at least six (6") inches above the top of the cover, or floor; or in lieu of such base, a separate water-tight metal cover in which the casing projects in like manner may be used.

Provided, That the base or cover may have an air vent constructed as hereinafter prescribed. Where power pumps are not placed directly over the well, the casing shall extend at least six (6") inches above the floor of the pump house. The annular space between the well casing and the suction pipe shall be closed to prevent entrance of contamination.

Well, Pump, Valve, and Pipe Pits. No wellhead, well casing, pump, pumping machinery, shall be located in any pit, room or space extending below ground level or in any room or space above the ground which is walled in or otherwise enclosed, so that it does not have free drainage by gravity to the surface of the ground; except in accordance with a design approved by the State Department of Health. Provided That this shall not apply to a dug well properly constructed as herein prescribed.

The requirements of this item shall be enforced only for water supply structures which are installed subsequent to the adoption of this Code, but existing pits shall be approved only if properly constructed in accordance with the requirements of the State Department of Health.

Manholes. Manholes may be provided on dug wells, reservoirs, tanks, and other similar water supply structures. Every such manhole shall be fitted with a water-tight collar or frame having edges which project at least six (6") inches above the level of the surrounding surface, and shall be provided with a solid water-tight cover having edges which overlap and project downward at least two (2") inches around the outside of the frame. Such covers shall be of standard design whenever possible to eliminate special fittings. The cover shall be kept locked at all times except when necessary to open the manhole.

Vent Openings. Any reservoir, well, tank, or other structure containing water for any such water supply may be provided with vents, overflows, or water-level control gages, so constructed as to prevent the entrance of birds, insects, dust, or other contaminating materials. Openings or vents shall face downward and shall not be less than two (2') feet above the floor of a pump room, the roof or cover of a reservoir, the ground surface, or the surface of other water supply structures.

Pump House. The pump house (1) shall be properly constructed to prevent flooding, (2) shall be provided with adequate floor drainage, and (3) shall be provided with properly designed and installed plumbing fixtures.

Lubrication of Pump Bearings. Pump bearings situated in any well below the pump room floor or platform shall be lubricated with water or oil of a safe sanitary quality.

Priming of Power Pumps. Priming type power pumps shall be primed only with water of a safe sanitary quality.

Priming of Hand Pumps; Buckets. Hand-operated pumps shall have cylinders submerged so that priming shall not be necessary. No pail and rope, bailer or chain-bucket systems shall be used.

Protection of Suction Pipes. All subsurface suction piping leading from detached wells or reservoirs shall be adequately protected against the entrance of contamination.

Valve boxes shall be provided for valves on buried suction lines. Every such valve box shall project at least six (6") inches above the floor if in a room or building and at least twelve (12") inches above the ground if not enclosed in a building. The top of the box shall be provided with a cover with overlapping edges.

Airlift Systems. The air compressor and appurtenances for any airlift system or mechanical aerating apparatus used in connection with a ground water supply shall be properly installed and operated.

Cross Connections. There shall be no physical connection between a safe public water supply and any other water supply which is not of equal sanitary quality and under as rigid official supervision, and there shall be no connection or arrangement by which unsafe water may enter a safe public water supply system.

Plant Supervision and Control. All public water supplies shall be under the supervision and control of a competent operator.

It shall be the duty of the mayor of each municipality, or of the person having responsible charge of a municipally owned water treatment plant, and of the proper officer of corporations and partnerships and of individuals, owning or operating a water treatment plant to furnish monthly reports to the State Department of Health.

Water Sampling. Chemical analyses and bacteriological examinations of water samples and tests for residual chlorine shall be made by approved methods and at proper intervals by the health officer or by laboratories approved by him.

Distribution. The distribution system shall be designed and constructed so as to prevent leakage of water due to defective materials, improper jointing, corrosion, settling, impacts, freezing, or other causes. Adequate valves and blow-offs shall be provided so that necessary repairs can be made with a minimum interruption of service.

Storage. All reservoirs, cisterns, and storage tanks shall be of watertight construction and made of concrete, steel, or wood; Provided: That wood shall not be used for reservoirs or storage tanks located wholly or partly underground.

Protection During Construction. All water supplies which are hereafter constructed, reconstructed, or extensively altered shall be adequately protected to prevent contamination of the source during construction.

Treatment of the supply by methods approved by the State Department of Health shall be provided to remove any objectionable characteristics of bacteria, when required by the State Health Officer.

Well water supplies which cannot be made safe by repair or reconstruction, or by treatment of the water, shall be abandoned. The wells shall be sealed to protect the water-bearing formation against possible contamination by the following or equal means:- (1) Drilled and cased wells shall be completely filled with neat cement grout, concrete, or clean puddled clay. (2) In driven wells the well point shall be with-drawn and the opening completely filled with neat cement grout, concrete, or clean puddled clay. (3) Dug or bored wells shall be completely filled with clean puddled clay or its equal after as much as possible of the curbing is removed.

Disinfection of Water Supply Systems. Pipes, pumps and other parts of water supply systems shall be disinfected when necessary.

Disinfection of New Water Supplies. Pumps, pipes, reservoirs and other parts of new systems shall be thoroughly disinfected by the use of chlorine or chlorine compounds before being placed in use. The rate of application of chlorine shall be in such proportion to the rate of water entering the pipe or other appurtenances that the chlorine dose applied to the water shall be at least 40 to 50 p.p.m. Chlorinated water shall be retained in the pipe long enough to destroy all non-spore-forming bacteria. The period shall be at least three hours and preferably longer, as may be directed. After the chlorine treated water has been retained for the required time, the chlorine residual at pipe extremities and at other representative points shall be at least 5 p.p.m. If the residual is less than 5 p.p.m., the sterilization procedure shall be repeated until a 5 p.p.m. residual is obtained, as required above.

Disinfection of Accidentally Contaminated Water Supplies. Water supply systems that may become contaminated accidentally, or otherwise, should be chlorinated continuously until the cause of the contamination has been found and corrected.

After the disinfection process has been completed the water containing residual chlorine should be flushed from the system, and water samples should be collected for bacteriological examination. The supply should not be used for potable purposes until found free from bacterial contamination, unless the water is boiled or otherwise sterilized.

Connection with Unsafe Water Sources Forbidden. There shall be no cross-connection, auxiliary intake, by-pass, inter-connection or other arrangement, including overhead leakage, whereby unsafe water, or water from a source that does not comply with these regulations, may be discharged or drawn into any drinking, culinary or ablutionary supply which does not comply with these requirements.

For the purpose of this Code the following definitions shall apply:- Cross-connection - (1) Any physical connection whereby the approved supply is connected with any other water supply system, whether public or private, either inside or outside of any building or buildings in such manner that a flow of water into the approved water supply is possible either through the manipulation of valves or because of ineffective check or back pressure valves, or because of any other arrangement.

(2) The use of valves, check or back pressure valves, is not an adequate protection against return flow, or back siphonage, or for the prevention of flow of water from an unapproved source into an approved system.

Auxiliary Intake. Any piping connection or other device whereby water may be secured from a source other than that normally used.

By-Pass. Any system of piping or other arrangement whereby the water may be diverted around any part or portion of a water purification plant.

Interconnection. Any system of piping or other arrangement whereby the public water supply is connected directly with a sewer drain, conduit, pool, storage reservoir, or other device which does or may contain sewage or other waste or liquid which would be capable of imparting contamination to the approved water supply.

No plumbing fixture or device shall be supplied directly from an approved water supply system through a flushometer or other valve unless such valve is installed in such a manner and with such additional devices as are necessary to eliminate any possibility of polluting the water supply.

No plumbing fixture, device or construction shall be installed which will provide an interconnection between a distribution system for an approved drinking, culinary or ablutionary water supply and a drainage, soil, or waste pipe so as to permit or make possible the back flow of sewage or waste into the water supply system.

Water from any drinking, culinary or ablutionary supply complying with these requirements may be supplied to any other system containing water of questionable quality only by means of an independent line discharging not less than six (6") inches above the overflow level of storage units open to atmospheric pressure or by other methods approved by the health officer.

Outlets From Unsafe Water Supplies Required to be Sealed or Labeled. All outlets from water sources which do not comply with these requirements shall be sealed, or, at the discretion of the health officer, be provided with a permanent and easily readable tag or label reading "UNSAFE WATER. DO NOT DRINK". Removal of said label or tag, except by permission of the health officer, shall be deemed a violation of these requirements.

Bottled Waters. All public ground water supplies put in bottles or, other containers, for use of consumers shall be so handled from source to ultimate use, as to prevent contamination of such ground waters originally obtained from approved sources.

The sale, or offering for sale, of chemicals which have not been approved by the State Department of Health for use in treatment of water to be used for drinking or culinary purposes is prohibited.

It shall be the duty of every person or officer, having authority and control in regard to any water designated for human consumption (and within the proper sphere of the duty of each thereof), to take all usual and also all reasonable measures and precautions to secure and preserve the purity and wholesomeness of such water.

It shall be the duty of the local departments of health to have made, through proper officers, an inspection of the sources of the water supply of the several communities under their jurisdiction as may be necessary in order to ascertain whether water from same is pure and wholesome and whether the rules and regulations of this Code are complied with.

No person shall bathe, wash animals or clothing, or deposit human excreta, or in any way contaminate any pond, lake or reservoir used as a public water supply. No person shall fish in a pond, lake or reservoir used as a public water supply without having first obtained written permission from the official in charge.

Sanitation of Watersheds. No cesspool, privy or other place for the deposit or storage of human excrement shall be located within 50 feet of the high water mark of any reservoir, stream, brook, or watercourse, flowing into any reservoir used for drinking purposes.

No cesspool, privy or other place for the deposit or storage of human excrement shall be located within 250 feet of the high water mark of any watercourse or reservoir as above mentioned unless such receptacle is so constructed that no portion of the contents can escape or be washed into the stream or reservoir.

No house slops, sink wastes, or other polluted water shall be discharged on the ground or

into the ground within 50 feet of the high water mark of any watercourse or reservoir as above mentioned and no house slops, sink wastes, or other polluted water shall be thrown on the ground within 250 feet of such waters.

No stable, pigpen, chicken house or other structure where the excrement of animals or fowls is allowed to accumulate, shall be located within 50 feet of the high water mark of any water-course or reservoir as above mentioned, and no structure of this character shall be located within 250 feet of the high water mark of such waters unless provision is made for preventing manure or other polluting materials from flowing or being washed into such waters.

The term high water mark as used in these regulations, means the contour line which is reached by the water at its maximum level in the pond, lake or reservoir.

Reporting Changes in Public Water Supplies. No officer, board, corporation or other person or group of persons owning, or having by law the management or control of, any potable public water supply of any municipality or water district, shall take or cause to be taken for use for potable purposes in such municipality or district, water from any auxiliary source other than the regular source or sources of public water supply or shall discontinue the chlorination or other treatment of such supply or shall make any change whatsoever which may affect the sanitary quality of such water without first having notified the local health officer or health officers of the municipalities, parishes or districts in which such water supply is used for potable purposes and affording him or them an opportunity to be heard. When such notice has been made to such health officer or health officers, the health officer or health officers shall immediately notify the state health officer by telephone or telegram.

A printed copy of this regulation shall be kept constantly posted in the office used by the authorities owning or having charge of a public water supply.

Cisterns used for drinking water shall be provided with a rain water cut-off, suitable to deflect the first washings of the roof and prevent contamination of the water. Cisterns shall be tightly covered, and screened with 18 mesh wire screen.

Drinking Water in Factories or other Industrial Plants. Wherever a potable public water supply is available, no other supply shall be furnished for drinking purposes to employees in any factory or industrial plant, or other place of business, unless such other supply is approved by the local health officer. If no public water supply is available, the water for drinking purposes shall be of safe, sanitary quality approved by the local health officer. If the water supply for industrial or fire protection purposes is obtained entirely or in part from a source not approved for drinking purposes, this supply shall be distributed through an independent piping system having no connection with the system carrying drinking water. All faucets or other outlets furnishing water which is not safe for drinking shall be conspiciously so marked.

Landlords to Supply Water. It shall be the duty of the owner of any premises or building, occupied as offices, tenement houses, lodging houses, hotels, or private residences, to provide an adequate safe supply of water for human consumption and sanitary purposes.

In all cases where the owner or owners of the property or premises referred to in this Code shall not reside in the place where the property is situated, or when such property shall belong to an estate, succession or corporation, it shall be the duty of the agent, or representative of the owners thereof, or the persons who shall have charge of said property for the owners thereof, or who shall collect the rent of such premises, if the same be rented, to provide and furnish such premises with adequate means and quantity of water by hydrant or cistern, at the expense of the owner or owners thereof, upon notice of any deficiency in that respect by the local board of health, State Department of Health or police authorities; and in case such owner, person or representative of the owner, shall fail or neglect to supply the same to such premises, within ten days after due notice, he shall be held responsible as owner as hereinafter provided.

School Water Supply. Each public, parochial and private school shall be provided with a water supply which is approved as to source, location and distribution by state and local departments of health.

Water for Employees. It shall be the duty of all employers to supply an adequate safe water supply for all employees.

Laboratory Examinations. Samples of water from all public supplies shall be examined at regular intervals. The laboratory making the examination, the frequency of examination, the tests used, and the standards for determining freedom from contamination shall meet

with the approval of the state and local departments of health.

Public Drinking Fountains. All public drinking fountains shall be of sanitary design and construction.

Connections to Public Water Supply. All inhabited premises and buildings located within [illegible] feet of an approved public water supply shall be connected with such supply unless given permission to use water from some other source by the state or local health officer.

When the water supply of any community, railroad station, public office building, water tank, or water plant, or any source of supply for human consumption, is examined by the State Department of Health and found unfit for human consumption, the public shall be notified by the posting on source of condemned supply of a warning metal sign (not less than 6 x 12 inches) with red background and white letters, that may be read at 120 feet.

It shall be unlawful for any person to remove, cover up, take down or otherwise destroy the sign, or other notice placed by any board of health, health officer, or duly authorized representative of said board, warning the public, "DO NOT DRINK THIS WATER".

References -

1. Preventive Medicine and Hygiene -- Rosenau
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3. Municipal and Rural Sanitation -- Ehlers and Steel
4. Louisiana Sanitary Code
5. Sedgewick's Principles of Sanitary Science and Public Health -- Prescott and Horwood
6. Public Health Engineering -- Phelps
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8. Water Supply and Sewerage -- E. W. Steel

Bathing Places

REPORT OF THE JOINT COMMITTEE ON BATHING PLACES
AMERICAN PUBLIC HEALTH ASSOCIATION AND
CONFERENCE OF STATE SANITARY ENGINEERS

STANDARDS FOR DESIGN, EQUIPMENT AND OPERATION.

I. Classification of Bathing Places

A. The term "bathing place" as used in this report includes all bodies of water sufficiently deep for complete immersion of the body and used collectively by numbers of persons for swimming or recreative bathing, together with the shores, buildings, equipment, and appurtenances pertaining to such bathing places. It does not include public or semi-public baths, where the main object is the cleansing of the body or the practice of the healing art, unless such baths contain pools or tanks used collectively by a number of individuals.

B. Bathing places may be divided into three classes: 1. Natural outdoor ponds, rivers, tidal waters, etc. 2. Outdoor pools which are partly artificial and partly natural in character. 3. Pools outdoor or indoor which are entirely of artificial construction.

Natural ponds and rivers are necessarily dependent upon natural flow or upon wind and wave action for circulation of the water. Artificial and partly artificial pools may be divided into four classes according to the method by which water cleanliness is obtained:

a. Large semi-artificial pools in which the water cleanliness is maintained by natural flow or circulation.
b. Fill and draw pools where cleanliness of water is maintained by complete removal and replacement of the water at periodic intervals.
c. Flowing through pools where cleanliness is maintained by circulation of water through the pool from some natural or artificial source, but where the outflowing water is wasted.
d. Recirculation pools in which circulation of the water is maintained through the pool by pumps, the water drawn from the pool being clarified by filtration before being returned.

II. General Principles of Bathing Place Sanitation

A. In the control of swimming pool and bathing place sanitation certain broad principles apply to all classes of public bathing places.

B. The committee is of the opinion that all public bathing places both natural and artificial should be under the sanitary control of the public health authorities.

C. In the opinion of the committee the same standards of cleanliness and bacterial purity of the water and the same precautions against the possible spread of disease should apply at both indoor and outdoor swimming pools.

D. The requirements should be the same for all artificial and semi-artificial pools whether located indoors or outdoors, so far as the features of design and equipment apply to maintenance of cleanliness of the pool and of the water with which it is filled.

E. At public bathing beaches on natural waters the same sanitary standards should apply to bathing houses, dressing rooms, toilet facilities, and to the handling and care of bathing suits, towels, and other articles of bathing apparel as would be required at artificial swimming pools.

F. Sanitary drinking fountains with a supply of pure water should be installed at all bathing places. The common use of towels, drinking cups, combs, hair brushes, or other toilet articles should be strictly prohibited.

III. Bathing Beaches

This subject is discussed in Sections XXIX to XXXIV of this report at considerably greater length than in the 1927 report.

IV. Location and Layout of Pools

A. The location of an outdoor pool will be governed largely by local conditions; and arrangement of dressing rooms, etc., can be made to conform to the sanitary requirements. In locating an indoor pool careful study must be given to architectural and engineering features in order that the proper layout may be obtained.

B. The layout or arrangement of entrances and exits of the pool room in relation to dressing rooms, showers and toilets must be such as to enforce proper routing of bathers. Coming from the dressing room a bather should be required to pass the toilets, and go through the shower room before arriving at the pool entrance. Bathers should leave the pool through a separate exit leading to toilets and dressing rooms.

C. At pools used simultaneously by both sexes separate entrances and exits should be provided for men and women. There should be no connection between men's and women's quarters.

D. Entrances and exits must be located at shallow water portion of the pool.

E. If the pool is to be of recirculation type, ample room must be provided for filters and other units. All recirculation piping, inlet and outlet valves, etc., must be located where they will be readily accessible.

F. At indoor pools where chlorine disinfection is to be used it is recommended that the chlorine apparatus be so located as to be readily observed.

V. Design and Construction Features

A. Material: Any material which will provide a tight tank with smooth and easily cleaned surfaces may be used for artificial swimming pools.

B. Details of design: The details of design in so far as they relate to strength of material, water-proofing, etc., are essentially the same as in design of other tanks of similar size and shape and are therefore, omitted from this report. In the design of a new pool provision should always be made for complete circulation of water through all parts of the pool during the bathing period. Without proper circulation it is difficult or impossible to maintain good sanitary conditions at all times, even though the pool be completely emptied, cleaned, and refilled each day. The installation of new fill and draw pools cannot be recommended.

C. Shape: Indoor pools should be of rectangular shape with deep water at or near the end and shallow water at the other. Small outdoor pools should be of the same general design as indoor pools. The best shape of large outdoor pools depends largely on the size and on local conditions. It is considered better practice to build large pools with the deep water area in the center.

D. Dimensions: For swimming records a straight away course of at least 60 feet with 5 foot lanes is required. Length of pool should be not less than 60 feet and width should be some multiple of 5 feet. The area to be provided for the expected bathing load is discussed in a subsequent chapter.

E. Depth of Water: The minimum depth of water in the deep portion of any public pool should be not less than 6 feet.

F. Proportion Deep and Shallow: Some authorities recommend that the area of shallow water, 5 feet or less in depth, should be 80 percent or more of the total area of large outdoor pools. Such proportioning must be considered in relation to the pool volume, the bathing load, the recirculation or flowing through purification system, etc. The committee has insufficient information on this point to warrant any recommendation at the present time.

G. Slope of Bottom: The slope of the bottom of any part of a pool where the water is less than 6 feet deep must not be more than 1 foot in each 15 feet. There should be no sudden changes of slope within the area where water depth is less than 6 feet.

H. Side Walls: The side and end walls of all artificial and semi-artificial pools should be vertical. Sloping side walls are dangerous and cannot easily be kept clean

I. Pool Lining: Including bottom and sides up to runways lining must be of white or light color material and present a smooth finished surface without cracks or joints. All corners must be rounded. Tile or glazed brick lining is recommended for all indoor pools and for small outdoor pools. White cement smoothly finished is satisfactory for large outdoor pools. Dirt does not show on asphalt or other similar dark material and such materials are not suitable for pool lining. Sand or earth bottoms cannot be kept clean and are not recommended for pools.

J. Markings: It is recommended that swimming lanes be marked on the bottom with dark colored material of the same kind as pool lining. The outlet of the pool should also be plainly marked by a black or dark colored circle, unless outlet grating is of conspicuous coloring. The depth of water at the deepest point and at the 5-foot point should be conspicuously marked on both sides of a pool with deep water at one end. Markings showing depths in 1 foot increments are desirable. In large pools with deep water only in the middle the 3 and 5 foot depth line should be conspicuously marked on the bottom and also designated by surface floats.

VI. Proportioning Pool Area to Expected Load

A. In the design of an artificial pool due allowance must be made for the number of bathers who may be expected at the time of maximum use. In computing the area which must be provided it is recommended that the pool be divided into three zones, and the area of each computed separately.

B. From the data collected by the committee for its fifth report it was the consensus of opinion that an area extending 10 feet from the extremity of a diving board or tower should be considered as reserved for divers, and that not more than two or three persons should be permitted in the water in this area at one time while diving is in progress. About three times that number will be on the shore or diving platform awaiting their turn to dive. Twelve persons is therefore the maximum number which may be permitted for the area within 10 foot radius of each diving board or platform.

C. It was the consensus of opinion of swimming pool operators that the space required by a swimmer might fairly be expressed as five-fourths the square of his height and that on an average two thirds of the swimmers present would be in the pool at the same time. On this basis the average space requirement for an adult swimmer is 36 square feet and allowing for one-third of swimmers on the shore, an average of 27 square feet should be provided for each swimmer who may be expected to be present at time of maximum load.

D. In computing the area to be provided for persons who do not swim we must take into consideration the character of the pool. At indoor pools and small outdoor pools this area should probably be included with the swimming area and the crowding limit computed as such. At large outdoor pools where a considerable proportion of the water is shallow water, we may assume that 50 per cent of the non-swimmers would be on shore. The average space allowance for each non-swimmer in the water is approximately one half that of the swimmer in deep water. Combining these factors an allowance of 10 square feet per bather should be allowed for this portion of the pool.

VII. Inlets and Outlets

A. All pools should be provided with an outlet at the deepest point of sufficient size to permit the pool to be completely drained in four hours or less. Outlet opening in the floor of the pool should be at least four times the area of the discharge pipe to reduce suction currents. This opening must be covered with a proper grating.

B. In rectangular pools with deep water at or near one end, multiple outlets should be provided where the width of the pool is more than 20 feet. In such cases, outlets should be spaced not more than 20 feet apart, nor more than 10 feet from sidewalls.

C. Proper pipe connections must be provided in recirculation pools to permit water being drained to the sewer as well as to recirculation pumps. No direct connections to sewers should be permitted and all pool drains to sewers should be broken at a point where any sewage which may back up from the sewer will overflow to waste instead of being permitted to reach the pool. Pumping of pool drainage to an elevation above any possible sewer backing may in some cases be needed.

D. Inlets for fresh or re-purified water should be located to produce so far as possible uniform circulation of water and the maintenance of a uniform chlorine residual throughout the entire pool. In semi-artificial pools of irregular shape a careful study should be made of probable circulation currents, and inlets should be located and spaced to provide as complete circulation as possible. Inlets from the circulation system should be submerged to reduce escape of chlorine odors. Where water from the public water system is added to the pool, cross-connections between the public water system and the swimming pool water should be eliminated by pumping make-up water from a pump suction well or admitting water to the pool above the overflow elevation of the pool. It is recognized that the avoidance of cross-connections in this manner may require the installation of a separate heater on the line supplying make-up water, particularly where large amounts of make-up water are added.

E. Where the distance across the shallow portion of the pool is more than 20 feet, multiple inlets must be provided, so spaced that each inlet will serve a linear distance of not more than 20 feet. At spoon shaped rectangular pools where the outlets are located more than 5 feet from the end wall, inlets should be placed at both ends of the pool. At large pools with outlets near the center, inlets should be placed at the specified intervals entirely around the perimeter of the pool.

F. Each inlet should be designed as an orifice and proportioned to supply the volume of water required at the particular point to obtain the best circulation. Inlet piping should be designed to provide at least twice the area of the inlet orifice. In large pools the inlet pipe system should be designed in sections with gates to permit regulation of the flow to different inlet orifices.

G. In a few cases pools have been designed for fresh water or re-purified water to enter at the deep point and overflow through outlets or scum gutters in the shallow portion. It is believed there may be some advantage in having flow through the pool in this direction, thus permitting floating matters and dirtier water from the more crowded shallow area to be carried off more rapidly. The committee suggests that in designing piping system for recirculation or flowing through pools, connections be provided so that flow through the pool may be in the direction which experiments may prove most desirable. It is also suggested that the question of having scum gutters serve as overflows and outlets in recirculation or flowing through systems be studied more carefully, as it appears that such design may have certain material advantages.

VIII. Scum Gutters

A. Scum gutters should extend completely around the pool. The design of scum gutters should be such that matters entering them will not be washed out by a sudden surge of entering water, and that danger of bathers catching arms or feet in them be reduced to a minimum. The edge of a scum gutter should be designed to serve as a hand hold for bathers. Gutters should, therefore, be sufficiently deep that bathers' fingers will not reach to the bottom. Sufficient opening must be provided to permit mechanical cleaning of the gutters.

B. Drainage outlets should be provided at least every 10 feet and the gutter bottom should pitch slightly to these outlets. Outlets and outlet pipes should be of generous size to permit rapid carrying away of water during surface flushing or reversed flow. Drainage from scum gutters may be conducted directly to sewers or to suction of recirculating pumps. Both such connections are advised.

C. All scum gutters should be recessed into the pool wall. There is no legitimate objection to having scum gutters project slightly into the pool to permit drainage from runways to flow directly over the edge of the pool into them. Such projection should not, however, be more than 2 inches.

IX. Steps, Ladders and Step Holes

A. Steps or stairways for entering and leaving the pools should be of such construction as to minimize danger of accidents. Ladders or stairways should be located at one or both sides of the deep end of the pool. If the distance from the bottom of the pool to runway is more than 2 feet, a ladder or steps should also be placed at the shallow end of the pool. Treads of ladders or steps should be of non-slip material.

B. In some pools ladders have been replaced by step holes inserted in the pool wall. If step holes are provided, they should be of such design that they may be readily cleaned and be provided with drains into the pool to prevent accumulation of dirt.

C. Stairs, ladders, or step holes should have a hand rail on either side at the top

leading out over the runway. Stairs should not project into the pool. If stairs desired, the stairway should be recessed into the wall and the runway of the pool.

X. Runways of Sidewalks

A. Runways not less than 4 feet wide should extend entirely around the pool. Runway floors should have a slope of about 1/4 inch to the foot, should be smooth and easily cleaned, but should be as far as possible of non-slip construction. The edge of the pool runway must be of non-slip construction for a width of at least 1 foot.The edge of the pool at its junction with the runways should be rounded. At indoor pools, unless runways are very wide, handrails on the outside wall are desirable.

B. The older practice was to require all runways to slope away from the pool with drainage vents at intervals connecting with the sewer. Such a requirement seems unnecessary for indoor pools. The water carried out on runway is of the same character as that in the pool. Modern trend of opinion is toward having runways of indoor pools slope toward the pool with drainage into scum gutter or scum gutter drainage system. At outdoor pools so located that much dirt is blown in from outside it is desirable to have the runways slope away from pool to permit flushing such dirt directly to the sewers.

C. Some sanitary authorities also require a raised edge 2 inches or more in height between the pool and runways. Such a raised edge may lead to accidents by bathers tripping thereon and cannot be recommended for indoor pools. At outdoor pools a raised edge forms a barrier between pool and runway and permits the use of greater hose pressure for flushing. If installed for this purpose, such an edge should be not less than 1 foot wide and at least 6 inches high in order that danger of accidental tripping may be reduced as much as possible.

D. High, tight walls should encircle the pool outside the runways. Some outdoor pools have been constructed with areas of sand or grass and shrubbery just outside the runways. This practice is objectionable as it leads to tracking of much dirt into the pool. Trees and shrubbery overhanging or adjacent to the pool or runways are also objectionable and may cause unnecessary dirt in the pool.

XI. Vistors' Galleries

There must be an absolute separation of the space used by spectators and that used by bathers. There should be no means by which bathers can enter space reserved for spectators or vice versa. Visitors quarters must have a separate entrance. Galleries for spectators should not overhand any portion of the pool surface. Floor and foot rail of the gallery should be tight construction to prevent dirt tracked in from getting into the pool. Gallery floor should slope to a drain and should be flushed down with hose regularly. Seats in galleries should be of non-absorbent construction to permit washing.

XII. Dressing Rooms

A. Bath houses to be used simultaneously by both men and women should have two parts, one of each sex, entirely separated by tight partitions.

B. Floors of all dressing rooms and locker rooms should be of smooth finished material, impervious to moisture, with no open cracks or joints. All floors should have a pitch of about 1/4 inch to the foot and should slope to a proper drain to permit washing down with a hose. All junctions of the floors with side walls and partitions should be finished with rounded joints.

C. Walls and partitions of all dressing rooms and locker rooms should be of smooth, impervious material, without open cracks or joints. If walls of wood or similar material are used, all cracks and joints should be filled and the surface kept finished with paint or other sanitary water proof coating. Partitions between dressing compartments should terminate not less than 4 inches above the floor to permit flushing of the entire floor area.

D. All furniture used in dressing rooms should be of simple character and of easily washable material. Lockers where provided should be of vermin proof construction with tight joints. All lockers should be properly ventilated.

E. All dressing rooms and appurtenances must be kept clean at all times. The use of an insecticide spray for lockers and of a disinfectant on floors, walls, and seats

at frequent intervals is recommended. A 0.3 to 0.6 per cent solution of available chlorine is suggested as a disinfectant, to prevent the spread of foot infections. Foot tubs without proper disinfectant solution should be prohibited.

XIII. Showers, Toilets, Lavatories

A. Adequate shower bath facilities with hot and cold water should be provided at all artificial pools. The minimum number of showers provided should be in the proportion of one for each 40 bathers expected at time of maximum load, in the case of continuous bathing. For bathing by classes, as at schools, the number of showers may be taken as one-third the number of pupils in the maximum class.

B. Shower baths should be of such design that a proper mixture of hot and cold water may be obtained without danger of scalding the bather. A bidet or upward flow spray beneath each shower to permit washing between the legs is desirable.

C. A foot trough with running water is desirable at entrance to outdoor pools and to beach bath houses. At certain pools operated in conjunction with surf bathing, it has been found advisable to make a wading pool of the entrance passage with automatic or continuous flow showers overhead, through which all bathers must pass on return to the pool.

D. At public bathing beaches a sufficient number of showers should be provided to permit all bathers to rinse off sand and dirt before entering the dressing rooms.

E. Adequate and proper toilet facilities for each sex must be provided at all pools and beach bath houses. The minimum number should be one toilet for each 40 women and one toilet and one urinal for each 60 men. Urinals should be of a type that will not cause splashing of urine upon legs and feet of bathers. Urinals and toilets should be so located that bathers will use them before entering the showers on their way to the swimming pool.

F. Water flush toilets should be provided wherever possible. All toilets must be properly maintained.

G. Lavatories located adjacent to toilets should be provided at all swimming pools in the proportion of the bowl to each 60 persons using the pool at time of maximum load.

H. The use of solutions containing 0.3 to 0.6 percent of available chlorine has been found of value as a foot wash for the prevention of so-called "athlete's foot". At many swimming pools, bathers are required to rinse their feet in such a solution before entering the pools. Many authorities consider it preferable to place the foot bath at the exit from the showers to the dressing rooms so as to spread the chlorine over the dressing room floor and increase the time of contact. In some cases, 15 percent sodium thiosulphate solutions have been used with success as a preventive foot wash but in one large city poor results with this chemical have been reported. One reason attributed to lack of success with sodium thiosulphate is failure to employ freshly made up solutions using a good grade of chemical. Sodium thiosulphate is a reducing agent and will reduce the available chlorine in the pool if bathers use it in a foot bath before entering the pool so that its use should be limited to bathers leaving the pool.

Another interesting recent development is a report from Detroit, Mich., that Dr. Loren Schaffer has conducted successful experiments with a 10 percent by weight salt NaCl solution for control of "athlete's foot". More data on this treatment will be awaited.

XIV. Lighting, Ventilation, Heating

A. A complete system of artificial lighting must be provided for all pools, bathing beaches, bath houses and dressing rooms which are to be used at night.

B. Lighting fixtures must be of such number and designs as to light all parts of the swimming pool and the water therein.

C. Arrangement and design of lights must be such that life guards may see clearly every part of the bathing waters at a beach or pool, and all spring boards, towers, floats, and other appurtenances, without being blinded by the light.

D. Indoor pools should be so located that they may be lighted during the day by windows

on at least one side or by skylight. The window or skylight area should not be less than one half the area of the pool including the runways.

E. All indoor pools and all bath houses, dressing rooms, shower rooms, and toilets at both indoor and outdoor pools and beaches, must be properly ventilated. Ventilation of indoor pool rooms must be so designed that direct draft will not blow on bathers.

F. All heating units shall be isolated or protected from contact with bathers to prevent injury. The heating units in dressing rooms, shower rooms, and toilets shall be capable of maintaining a temperature between 70°F. and 75°F. The pool room heating units shall be capable of maintaining a temperature between 75°F. and 82°F. Thermostatic control of the temperature is desirable.

G. The acoustical property of pool rooms has not received the attention it deserves. Designs and materials of construction, which will prevent reverberations of sound that result in confused noises, should be used. It is very important that an instructor's voice or a call for help may be clearly distinguished.

XV. Recirculation System

A. The System: The recirculation system consists of pumps, hair-catcher, and filters together with all necessary pipe connections to the inlets and outlets of the pool. The water heater, the chlorinator and the suction cleaner are also usually installed on or connected with the recirculation system and may be considered as integral parts thereof. This entire system and all its component parts should be designed to provide the required volume of recirculation water as specified in section XVI,B. with a minimum of frictional resistance. Filtration and disinfection are discussed separately in subsequent chapters. The requirements for other parts of this system are as follows:

B. Pumps: Centrifugal pumps are preferable for swimming pool circulation, although plunger pumps are sometimes used. Electric drive is also preferable. When pipe lines from suction cleaner lead to pump suction, a pump which will develop good vacuum must be used. When pressure filters are used pumps must be designed to pass the required volume under the maximum head which may develop in the filters. When designed to operate with multiple unit filters it is advisable to have pumps in duplicate with proper cross-connections to permit one filter to be washed with the effluent from another. If filters are located at an elevation higher than the water line of the pool a check valve must be placed on the pump suction.

C. Hair Catcher: The recirculation system should include a strainer to prevent hair, lint, etc., from reaching the filters. The best type of hair catcher consists of a metal chamber containing a removable cylindrical strainer, so arranged that the water passes through the strainer from the outside. The strainer should be of non-corrosive material with openings not more than 1/32 inch across. A slotted strainer is more easily cleaned than one which is perforated. The area of strainer openings should be at least ten times the area of the water inlets. Hair traps should be so constructed that they can be quickly taken down for cleaning by loosening two or three wing-nuts. Proper valves should be provided to prevent flow of water through the strainer while cleaning.

D. Water Heater: In northern climates some method of heating the water is essential for indoor pools. Blowing steam directly into the pool as is practiced in some instances or heating coils placed directly in the pool are not recommended. A heater designed to heat all or a part of the circulation water is preferable. In designing a heater, ample surface for heat interchange must be provided. Such a heater may be designed for use with steam or hot water. Automatic thermal control is desirable. Provision should be made for easy removal of the heater parts for cleaning.

E. Suction Cleaner: In the opinion of the committee the only satisfactory method of removing the dirt, hair, etc. settling on the bottom of a pool is by means of a suction cleaner. As such cleaners are commonly operated by the circulation pumps, they may be classed as an adjunct to the recirculation system. When a suction cleaner is to be operated by the recirculation pump, a gate with graduated stem or other registering device should be provided for throttling the flow from the pool outlet to permit the pump to operate at maximum efficiency when the suction cleaner is in use. Fixed pipe connections below the water surface for attachment of suction cleaner to pump suction should be of ample size to reduce friction to a minimum and the cleaner and all removable connections should be designed to provide a maximum velocity at the suction nozzle.

F. Piping System: The piping system should be properly designed to reduce friction losses to a minimum. Pipe capacities should generally be at least double the theoretical value. Flange joints or unions should be inserted at intervals to permit any part of the system to be quickly taken down for cleaning or repairs. A sump and blow-off should be provided at the lowest part of the system to permit removal of any accumulating iron rust. Openings should be provided for insertion of gauges to permit vacuum or pump suction and pressure at discharge to be determined, should a study of the recirculation system be desirable. It is advisable also to make provision for insertion of pitot tubes or meters for checking the actual volume of water passing through the system under working conditions. Outlets should be provided for obtaining samples of the water as it leaves the pool and after filtration for purposes of laboratory tests. Other requirements for piping are discussed under the heading "Inlets and Outlets".

G. Testing the System: After the recirculation system has been installed and the various units tuned up, a test of the hydraulic properties of the entire system and of each integral unit should be made. In such a test the velocity in the piping system at various points, the discharge capacity of each filter and each pump, the velocity and volume of wash water in each filter, and the rate of discharge at each pool inlet should be determined under actual working conditions with the pool at normal working level. The full data of this test should be a matter of permanent record for future comparison. A similar test repeated at least once a year is desirable.

H. Thermometers: At indoor pools a fixed thermometer shall be placed on the recirculation line beyond the heater and another near the outlet of the pool. At outdoor pools one thermometer is usually sufficient. Thermometers shall be accessible and have a type of scale that is easily interpreted.

I. Cross-connections: The avoidance of cross-connections on the pool piping system whereby pool water may under some conditions enter a potable water supply system which is connected either for admission of new water to the pool or for washing of filters is discussed in sections VII D and XVII E. The possibility of polluting pool water from sewer connections is discussed in section VII C. The dangers of cross-connections are also stressed under this heading.

XVI. Proportioning the Water Interchange for Recirculation and Flowing Through Pools

A. In a recirculation of flowing through pool in which the dirty or used water is continually being withdrawn and replaced by fresh or filtered water, purification of the pool water proceeds by consecutive dilution. The first portion withdrawn from the pool will all be dirty water but, owing to the constant admixture of entering clean water with the dirty water remaining in the pool, each succeeding portion of water withdrawn will consist of a decreasing proportion of dirty water mixed with an increasing proportion of clean water. In proportioning the rate at which fresh water should be added to a flowing through pool, or the capacity of pumps, filters, etc., for a recirculation pool, this law must be taken into consideration.

B. Gage and Bidwell have worked out the law of purification by consecutive dilution as applied to recirculation and flowing through pools and this is described by them as follows: It is proposed that the rate of water interchange in a recirculation or flowing through pool be expressed as the ratio of the volume of clean water entering the pool in 24 hours to the total pool volume. For convenience this ratio may be called the "turnover" rate of "T" of the pool purification system. For example T - 1 when the volume of water recirculated in 24 hours is the same as the pool volume, T - 2 when the water circulated in 24 hours is twice the pool volume, etc.

It can readily be demonstrated by computation and by experiment that 7 turnovers are required to effect a removal of 99.9 percent of the dirt present in the water of the pool when recirculation was started. At the end of the first turnover, the purification will be about 63 percent, after two turnovers about 86 percent, at the end of three turnovers about 95 percent, after four turnovers about 98 percent, after five turnovers 99.3 percent, and after six turnovers 99.7 percent. To accomplish a purification of 99.99 percent, 10 turnovers will be required.

If the pool is used regularly by bathers further increments of dirt will be introduced into the water daily, and the removal of each successive daily increment will proceed according to the law. The result of the addition of such daily increments will be an increasing accumulation of dirt in the water up to a certain point, after

which the dirt content of the pool water will remain practically constant, subject only to the fluctuations caused by the variations in the daily bathing load. The amount of this accumulation and the time required for the pool water to reach a condition of equilibrium depend upon the rate of turnover of the pool by the flowing through or by the recirculation system, and in the latter system is also dependent upon the efficiency of the filters.

Assuming a daily increment of dirt equal to that in the pool at the start and a filter efficiency of 100 percent, with a daily turnover (T = 1) equilibrium will be reached at the end of the ninth day when the accumulated dirt in the pool will be equivalent to about 58 percent of the amount present when recirculation and daily bathing was started. With two turnovers per day (T = 2) equilibrium will be obtained in four days with a dirt load of about 16 percent; with(T = 3)a balanced load of about 5 per cent will be obtained on the third day,and with(T = 4)a balanced load of about 2 per cent will be obtained at the end of the second day. On the other hand, if the recirculation system is so small that it required two days for each turnover, accumulation of dirt in the pool will continue for about nineteen days and the dirt load carried in the pool thereafter will be about 155 per cent of the amount present at the start.

It is evident, therefore, that if clean water is to be maintained, the recirculation or flowing through system must be designed to provide a turnover ratio of at least two and that where heavy bathing loads are anticipated, the turnover ratio should be three or more. It is also evident that the recirculation or flowing through system should be kept in operation continuously and that the filters should be operated in the most efficient manner. If the filters have an efficiency of only 50 per cent,or the recirculation system is operated only half the time, the effect will be the same as though the recirculation system were only half the size.

XVII. Filtration

A. Slow sand filters, rapid gravity filters and pressure filters have all been used in swimming pool repurification systems. More than 80 per cent of the recirculation pools in this country are equipped with pressure filters and for indoor pools and small pools where space is limited, this type of filter is to be preferred unless the water is very hard. For large outdoor pools the gravity type rapid filter is suitable and is preferred by some sanitary authorities. Where the water is very hard and cementation of the filter medium is likely to occur the open type of filter is to be preferred. Because of the large amount of space required, and the increased amount of hand labor required in cleaning, slow sand filters are seldom used for swimming pools.

B. Batteries of three or more filters arranged in parallel are preferable to a single unit, in order to permit continuation of filtration and recirculation while one unit is out of operation for cleaning or repairs.

C. Filtering material should consist of at least 36 inches in depth of suitable grades of screened sharp filter sand or crushed quartz and filter gravel. Experience has shown that satisfactory results are secured when the effective size of the sand is about 0.4 to 0.5 mm. with a uniformity coefficient not exceeding 1.75. Sand should be washed free from clay, organic matter, and soluble material. There should be at least 18 inches of freeboard above the surface of the filter material to the overflow troughs or pipes of rapid filters to permit proper washing without loss of filter sand. In some cases filters of bone charcoal, wood charcoal, or similar material have been installed on swimming pool recirculation systems. When new, these materials may have considerable absorptive effect, but after a few weeks' use this power is lost and the filter becomes practically worthless until the filter medium is renewed.

D. In designing a filter system for a swimming pool the rate of slow sand filters should not exceed three million gallons per acre per day, and the rate of rapid filters should not exceed three gallons per minute per square foot of surface area. Automatic rate controllers are essential on slow sand filters. Rate controllers are not usually installed on the rapid filters used for small swimming pools because of the considerable increase in cost. Filters for large pools(100,000 gallons or more) should be equipped with rate controllers and such control is desirable on smaller installations.

E. Rapid filters of open gravity type must be equipped with loss of head gauges. Pressure filters must be equipped with pressure gauges, on both the inlet pipe and the outlet pipe for determination of loss of head or back pressure in the filter medium. Pressure filters should have a proper sight glass installed on the waste discharge

pipe by which the operator may watch the progress of filter washing. Such glass should be readily removatle for cleaning, and should be kept clean. When pressure filters are located at an elevation above the water line of the pool, each filter must be equipped with an automatic air relief valve. The arrangement and number of valves and interconnecting piping, or "valve nest", for necessary and convenient operation of rapid filters is fairly well standardized, and a discussion thereof may be omitted. It is usually desirable to have 3 or preferably 4 pressure filter units so that 1 unit can be cut out of use and washed with the filtered pool water. With 4 filter units in ordinary use, 1 filter can be washed with the use of the recirculation pump at 4 times the ordinary filtering rate. If washing with the recirculation pump is not feasible, a wash water pump of higher capacity may be installed and a suction well or small elevated feed tank, supplied from above with water from the public water system, can be used to supply water to the pump. Valved cross-connections whereby water from a potable water supply may be admitted directly to the recirculation system for the purpose of filter washing may permit pool water to gain access to the potable water supply because of leaking valves or suddenly lowered pressures. They shall not be permitted in the case of new swimming pools. In some instances, the elimination of existing cross-connections between potable water supply systems and swimming pools is difficult. Each case should be considered in the light of existing conditions and remedies should be sought as dictated by the relative danger and the practicality of carrying out improvements. Where such cross-connections are permitted to remain in existing swimming pools, extraordinary precautions should be required to safeguard the potable water supply.

F. Readily removable heads or a large manhold should be provided on pressure filters to facilitate inspection and repairs. Sufficient head room and working space must be allowed about filter units of all types to permit sand replacement and other repairs when necessary.

G. If the water supply contains iron, manganese, turbidity, or any appreciable amount of color, treatment with alum or other coagulant will be necessary with slow sand filters as well as with filters of the rapid flow type. On filters for pools of more than 50,000 gallons capacity, solution tanks and orifice boxes are to be preferred to the "alum pot", so-called, which is usually installed for use with small filters.

H. When the water supply for a pool contains large quantities of calcium bicarbonates, and especially when such water must be heated for use,difficulty is often experienced in maintaining clear water in the pool by the usual methods of coagulation and filtration. To a certain extent this difficulty may be overcome by passing the alum-treated water through a properly designed coagulation and sedimentation basin before filtration. Where the installation of a proper coagulation basin is impracticable it is suggested that water softening apparatus of the zeolite or base exchange type be installed as an adjunct to the recirculation system to permit the calcium content of the pool water to be reduced to a reasonable amount.

XVIII. Disinfection

A. From all available information, the addition of chlorine either as a gas or in a water solution by use of proper apparatus is today the most satisfactory method of pool disinfection. It is possible not only to disinfect the entire body of water in the pool completely with chlorine, but also maintain in the pool water at all times a residual amount of disinfectant to counteract at once any dangerous pollution disseminated by bathers. With the proper chlorine apparatus it is also possible to increase or diminish the dosage as required to compensate for variations in the bathing load. The committee recommends the use of chlorine either as a gas or in a water solution for disinfection of all pools where there is any appreciable bathing load, or where bathing suits are worn. Recent developments indicate that the use of ammonia and chlorine for swimming pool disinfection has become increasingly popular because of the more lasting qualities of the chloramines thus formed and the possibility of carrying higher disinfecting dosages without production of irritating effects from the use of large amounts of chlorine. Reports have reached the committee that much more satisfactory results from the standpoint of avoidance of loss of chlorine from disinfected swimming pool water and of less trouble with chlorine odors have been obtained by carrying high alkalinities in the water. Experiments indicate a delayed germicidal action of chlorine with high accompanying pH content of the swimming pool water, decidedly so at a pH of 7.7, which is a factor to be considered. The fact that chloramines are decidedly slower-acting disinfectants than chlorine alone, makes it appear to the committee that chlorine is a safer disinfectant than chlorine and ammonia, although under some conditions such as in very

large or outdoor pools, chloramine disinfection may produce better over-all results.

Attention is called to experience in some pools where chlorine and ammonia have been used and where there has been developed the presence of excessive amounts of nitrites. These have caused false readings with the orthotolidin test for residual chlorine. The committee recommends that where chlorine and ammonia are used, frequent nitrite determinations be made on the swimming pool water in addition to the check routine bacteriological examinations. Even in pools where chloramine disinfection is not employed, it may prove advisable to make some tests for nitrites. They have been found to a noticeable extent occasionally in such pools.

B. The hazard of accidental escape of chlorine gas into public buildings is such as to warrant special precautions. It is suggested that:

1. The chlorine and chlorine equipment should be placed in a separate room which is reasonably gas tight and equipped with air eduction ducts beginning near the floor level and terminating out of doors. It is preferable to equip such rooms with forced mechanical ventilation capable of changing the air therein at least twice each minute. If the location is below ground level such mechanical ventilation should be considered a minimum requirement, since chlorine gas is heavier than air and will not rise from sub-ground levels.

2. The chlorine equipment placed therein should be of rugged design capable of withstanding reasonable wear and tear without developing leaks.

3. Some form of protection should be provided for emergencies. Several types of gas masks approved by the U. S. Bureau of Mines and suitable for high concentrations of chlorine are available. For this purpose, a sufficient number of suitable gas masks should be at hand and located at a readily accessible point outside of the area likely to be affected in case of accident. The instructions accompanying a mask concerning its care and use should be obeyed implicitly. Everyone who is in danger of being accidently exposed to high concentrations of chlorine should be provided with a gas mask. Periodic strict inspection and maintenance of approved gas masks are essential.

C. There are now on the market machines which feed hypochlorite solutions for disinfection. Chlorine compounds may be used to make up fairly stable disinfecting solutions and so long as their strength is checked by means of residual chlorine tests on the pool water, they may be very satisfactory. There are also chlorinators in use which produce chlorine by electrolytic action on sodium chloride solutions.

D. Intermittent disinfection with hypochlorites as practiced at many pools must be considered a makeshift. It is possible to obtain satisfactory disinfection by intermittent application of these chemicals and to maintain a satisfactory residual chlorine content in the water when the bathing load is constant and not too high. When the bathing load fluctuates widely the residual chlorine content cannot be adjusted to compensate for these variations and under excess loads immediate disinfection of infectious matters from bathers may not be accomplished.

E. Sterilization of clear water may be obtained by exposure in thin films of ultra-violet rays. It is claimed by the proponents of this method of swimming pool disinfection that the water after treatment contains a residual disinfecting agent whose action is similar in effect to that which is obtained by the use of a slight excess of chlorine either as gas or in solution. So far as the committee have been been able to determine no conclusive evidence has been produced to establish the claim. Until such evidence is produced it must be assumed that disinfection by this process proceeds according to the law of purification by consecutive dilution and is subject to the limitations imposed by that law. On this assumption there is never any definite and determinable amount of disinfectant in the pool water to act on infectious material which may be discharged by bathers during the bathing period at the time when such material is most dangerous. In a few cases, satisfactory control of the bacterial content of pool water has been reported by the use of ultra-violet disinfection alone. In a considerable number of instances, however, it has been found advisable to reinforce or supplement the ultra-violet treatment by treatment of the pool with chlorine or hypochlorites. Until reliable evidence is produced that ultra-violet treatment will cause the pool water to contain a sufficient residual disinfectant to take care of casual contamination and until methods have been devised by which any such residual disinfecting action can be readily determined and controlled, the committee cannot recommend the use of violet-ray apparatus alone for disinfection of any pool where the bathing load is high or where large temporary loads are likely to occur.

F. Judging from a few reports, a reasonably satisfactory disinfection of water may be accomplished by ozone when the necessary apparatus is properly installed and operated. The data on the use of ozone for swimming pool disinfection are very few and inconclusive. There is no evidence that ozone has any residual sterilizing effect after the water has been treated, and disinfection must, therefore, proceed according to the law of consecutive dilution and be subject to all limitations by that law. On the basis of any available evidence, the committee cannot recommend this method for swimming pool disinfection.

G. The committee recommends the use of copper sulphate in combination with either of the approved methods of disinfection at such times and in such amounts as may be necessary to control growths of algae in swimming pools and other bathing waters. The use of copper salts alone as a disinfectant will not produce satisfactory bacterial control and cannot be recommended.

H. The use of ionized silver for swimming pool disinfection has been developed abroad and to a very limited extent in this country. While satisfactory bacteriological conditions have been reported in pools using such treatment, there is a question as to how rapidly this disinfectant acts on infectious material which may be discharged into the pool water by bathers. Hale and Shapiro report poor disinfection with ionized silver treatment in New York City in experimental tests and during 5 months practical tests in a swimming pool and call attention to the relatively high cost of such treatment and to interfering substances such as ammonium salts. Mallmann also reports on operating results in a pool where ionized silver treatment was tried. He concludes that silver appears to be slower in its germicidal action than chlorine when applied in a disinfectant for swimming pools and bathing loads must be lower for silver treated swimming pools than when chlorine is used. He found 3 non-pathogenic bacteria that grew abundantly in swimming pool water containing silver. In the light of available information the committee cannot recommend the use of ionized silver for swimming pool disinfection.

XIX. Diving Towers, Spring Boards and Floats

A. Diving towers, when provided, shall be rigidly constructed and properly anchored to the bottom with sufficient bracing to insure stability under the heaviest possible load.

B. Fixed platforms and floats in the water shall be constructed with an air space of at least 1 foot beneath. There must be as little under water construction in such platforms as is consistent with strength, and all braces, struts, etc.,shall be designed to prevent entanglement of trapping of bathers beneath the platform.

C. At least 13 feet free and unobstructed head room must be provided above diving boards and towers.

D. No diving board or platform more than 10 feet above water level should be permitted at any public place. The elevation of diving boards or towers should not exceed the safe limit for the average swimmer. The consensus of opinion of swimming instructors, etc., as summarized in the fifth report of this committee apparently establishes the following as the minimum safe depth of water for diving from various elevations:

Elevation of Diving Platform	Minimum Safe Depth of Water
1 foot	5 feet
3 feet	6 feet
5 feet	7 feet
7 feet	8 feet
10 feet	9 feet

XX. Emergency Equipment

A. Pole hooks, ropes, buoys, and other necessary life saving equipment must be provided and be readily accessible at all pools and bathing beaches.

B. A first aid kit containing aromatic ammonia, tincture of iodine, sterile gauze, absorbent cotton, surgeon's plaster, and bandages of various widths should be provided for emergency use at all public bathing places.

XXI. Suits, Towels and Caps

A. At indoor pools used exclusively by men, nude bathing should be required. At indoor pools used exclusively by women bathing suits should be of the simplest type. Suits when used should be of wool or cotton of simple design and of undyed material or tested for fastness of color. Elaborate suits of varied materials or varied colors should not be permitted.

B. At artificial pools all bathers of both sexes should be required to wear rubber bathing caps.

C. It is desirable at artificial pools that all suits and towels be supplied and cared for by the management. If individually owned suits are permitted, they should be of prescribed style and material and should be laundered and stored at the pool by the management.

D. All suits and towels must be washed with soap and boiling water, rinsed, and thoroughly dried each time they are used.

E. Unless suits and towels are sent to a public laundry, the installation and use of modern laundry equipment at all public bath houses and pools should be required. Cold water washing and air drying should be prohibited. The use of a disinfectant on suits and towels in place of proper laundry methods is a makeshift which should not be permitted.

F. A sufficient number of suits and towels should be provided to take care of the maximum number of bathers. Unless thoroughly dried by artificial heat in a modern laundry drier, suits and towels should not be re-issued on the same day that they have been used.

G. Clean suits and towels must be kept strictly separated from those which have been used and unlaundered. Clean suits and towels must not be stored on shelves, handled in baskets or passed out over counters where dirty suits have been.

XXII. Supervision of Bathers

A. A swimming instructor, bathing master or other qualified attendant should be on duty at the pool side at all times when a pool is open to use by bathers. Such attendant should be in full charge of bathing and have authority to enforce all rules of safety and sanitation.

B. An attendant should be on duty at the shower room or entrance to the pool to inspect all bathers for skin diseases, open lesions, etc., and to insure that a proper cleansing bath has been taken.

C. At public bathing beaches one or more life guards should be on duty during all bathing hours.

D. Swimming pool attendants and life guards should be capable swimmers, competent in life saving methods and in methods of artificial resuscitation.

E. No bather should be permitted to enter the pool room or pool enclosure unless an attendant or other competent person is present. Solo bathing must be absolutely prohibited at all pools.

XXIII. Personal Regulations

A. All persons using a swimming pool must be required to take a cleansing shower bath in the nude, using warm water and soap, and thoroughly rinsing off all soap suds, before entering the pool room or enclosure. A bath after donning a bathing suit should not be permitted.

B. A bather leaving the pool room or enclosure for any reason should take a foot bath before returning. A bather leaving pool to use toilet should be required to take a second cleansing bath before returning.

C. All bathers should be instructed to use the toilet and particularly to empty the bladder before taking cleansing bath and entering the pool.

D. Any person having any skin disease, sore or inflamed eyes, cold, nasal or ear discharges, or any communicable disease must be excluded from a public swimming pool.

E. Persons having any considerable area of exposed sub-epidermal tissue, open blisters, cuts, etc., should be warned that these are likely to become infected and advised not to use the pool.

F. Spitting, spouting of water, blowing the nose, etc., in the pool should be strictly prohibited. Bathers should be instructed that the scum gutter is provided for expectoration.

G. All bathers should be instructed that blowing the nose to remove water is likely to force infectious matter into the sinus and inner ear cavities and possibly cause serious consequences.

H. Divers should be advised to wear rubber caps over the ears or to plug the ears with greased cotton to prevent infection of the ear drum and passages by water forged in by concussion.

I. No boisterous or rough play, except supervised water sports should be permitted in the pool, on the runways, diving boards, floats, platforms, or in dressing rooms, shower rooms, etc.

J. Suitable placards embodying the above personal regulations and instructions and those relating to suits and towels should be conspicuously posted in the pool room or enclosure and in the dressing rooms and offices at all swimming pools. At a number of boys' club pools, the boys are required to memorize the rules for safety and sanitation as a prerequisite to use of the pool.

XXIV. Chemical and Physical Quality of Swimming Pool Water

A. Excess Chlorine: Whenever chlorine, calcium hypochlorite, or other chlorine compounds without the use of ammonia, are used for swimming pool disinfection, the amount of available or excess chlorine in the water at all times when the pool is in use shall not be less than 0.4 p.p.m. or more than 0.6 p.p.m. Whenever chlorine or chlorine compounds are used with ammonia, the amount of available or excess chloramine shall not be less than 0.7 p.p.m. or more than 1.0 p.p.m. Attention is directed to the possibility of interference by nitrites with the orthotolidin test, particularly when chlorine-ammonia disinfection is employed. If readings are made on the water to be tested within 5 to 10 minutes after the orthotolidin is added, and samples are kept away from the light during this period, the nitrite interference will be decidedly lessened. Standards for determining chlorine residuals shall be prepared and used according to the recommendations in Standard Methods of Water Analysis of the American Public Health Association. Standardized color discs and comparators may be used.

b. Acidity-Alkalinity: Whenever alum or sulphate of alumina is used during purification or repurification of swimming pool waters, the water at all times when pool is in use shall show an alkaline reaction. This means that the hydrogen ion content of the pool water shall not fall below 7.0.

C. Clearness: At all times when the pool is in use the water shall be sufficiently clear to permit a black disc 6 inches in diameter on a white field, when placed on the bottom of the pool at the deepest point, to be clearly visible from the side walks of the pool at all distances up to 10 yards measured from a line drawn across the pool through said disc.

D. Temperature: The water in any swimming pool should not be artificially heated to a temperature above 78°F. The temperature of the air at any artificially heated swimming pool must not be permitted to become more than 8°F. warmer nor more than 2°F. colder than the water in the pool at any time when the pool is in use. For best results it is desirable that air temperatures shall be about 5°F. warmer than the pool temperature.

XXV. Bacterial Quality of Swimming Pool Waters

A. Bacteria Count on Standard Nutrient Agar - 24 hours - 37 C. - and Confirmed Test: Not more than 15 percent of the samples covering any considerable period of time shall contain more than 200 bacteria per ml. or shall show positive test (confirmed test) in any of five 10 ml. portions of water at times when the pool is in use. All primary fermentation tubes showing gas should be confirmed.

B. All chemical and bacterial analyses should be made in accordance with the procedures

recommended in the Standard Methods of Water Analysis of the American Public Health Association, in so far as these methods are applicable to swimming pool waters. In order to secure a true picture of the condition of the swimming pool water at the time of sampling, it is recommended that sodium thiosulphate be employed to neutralize the chlorine in the water sample bottle during transportation to the laboratory.

C. The part played by the various strains of streptococci in the respiratory diseases and their prevalence in the intestinal, buccal, and nasal discharges make the presence of streptococci in bathing waters very undesirable. Yet to eliminate them from swimming pools would mean decidedly smaller bathing loads and decided increases in chlorine residuals, either or both of which would hamper the usefulness of the pool. The committee calls attention to the fact that streptococci tests are of value in passing on the conditions of swimming pool water but does not recommend any uniform standard limit for their presence.

D. 1. Preparation of bottle for sampling:
All bottles of chlorinated swimming pool water shall be collected in bottles treated with sodium thiosulphate. The purpose of using water sample bottles containing sodium thiosulphate is to reduce the chlorine present in a treated water at the moment the sample is collected to prevent a continuance of the killing action of the chlorine on the bacteria while the sample is being transported to the laboratory. The bacteriological examination then shows the true sanitary quality of the water at the time the sample was collected.

2. Several procedures for preparing the bottles are presented:

For moist heat sterilization - Option 1. The sodium thiosulphate solution is prepared by dissolving 1.5 gram of sodium thiosulphate in 100 ml. of distilled water. One-half ml. of this solution is placed in each clean bottle. (this amount has been found sufficient to reduce completely residual chlorine in an amount up to 2.0 p.p.m. in a sample of 130 ml. of water). After the introduction of the sodium thiosulphate solution the bottle is stoppered and capped. The bottles are then placed in an autoclave and sterilized for 15 minutes at a pressure of 20 lb. per sq. in. Option 2. Into clean wet bottles, add approximately 0.02 to 0.05 gm. of powdered sodium thiosulphate. The amount need not be weighed. An estimated amount on the tip of a spatula is sufficiently accurate. The bottles are sterilized as in Option 1.

For dry heat sterilization - Into clean dry bottles is added from 0.02 to 0.05 gm. of powdered sodium thiosulphate as in A, Option 2. The bottles are stoppered, capped, and sterilized at 180°C. for 10 minutes. The temperature of sterilization must not approach 220°C. as sodium thiosulphate decomposes at this temperature.

E. Collection of Samples: The samples should be collected by plunging the open bottle beneath the surface, sweeping the bottle forward until filled. The bottle should not be rinsed in the pool or the sodium thiosulphate will be removed. Samples should be collected only when the pool is in use and preferably during periods of heaviest bathing loads during the day. The hour of the day, the day of the week, frequency of collection, and the location of the point of sampling shall be varied in order to obtain over a period of time a representative cross-section of the sanitary quality of the pool. It is desirable whenever facilities permit, to collect one or more samples weekly from swimming pools.

XXVII. Bathing Load Limits

A. Frequency of Changing Water

1. The purpose of recirculation is primarily twofold, first to remove suspended material and thus produce a clear water and secondly, to carry chlorine or chloramine to the water in the pool and thus maintain proper chlorine residuals in the pool water. The clarity of the water is related to the efficiency of the chlorine, in that the presence of suspended material reduces the effectiveness of the residual chlorine. In general, as discussed in Section XVI B, it has been found that the rate of turnover should be 3 times daily where continuous circulation is used.

2. The total number of bathers using a fill and draw swimming pool shall not exceed one person for each 500 gallons of water in the pool between complete changes of pool water without disinfection. Where intermittent disinfection is employed, the number of bathers using the pool will be governed by the safe limits mentioned under "Proportioning Pool Area to Expected Load", and by bacteriological

analyses of the pool water. Chlorine residuals should be maintained within the limits discussed in Section XXIV A. The committee does not recommend the use of fill and draw swimming pools, as stated elsewhere.

3. The total number of bathers using an outdoor pool - partly artificial and partly natural in character, dependent for circulation and replenishment upon an inflow and outflow of water from the supply of a clean stream which is relatively free from bacterial pollution or of a safe well or spring - might be based upon a figure of one person for each 500 gallons of water added to the pool as a maximum limit, although safe bacteriological conditions should be the principal guide. Where pre-cleansing baths are not used at such pools, reductions in bathing loads will undoubtedly be found necessary to maintain safe bacteriological conditions even with high chlorine residuals. Pre-cleansing baths should, of course, be provided at all pools.

B. Frequency of Disinfection: The committee has decided to omit a previous recommendation as to bathing load limits between successive disinfections in pools practising intermittent chlorine disinfection in view of the recommendations as to maintenance of adequate chlorine residual at all times the pool is in use. It is pointed out that experience indicates that far better bacteriological conditions can be maintained with continuous chlorine disinfection. Where a pool is operated with wide fluctuation in chlorine residuals, chlorine resistant organisms may develop at times when the chlorine residual content of the water is low, and it may be necessary to use very high chlorine residuals to destroy them.

C. Area Limitation: One investigator (Mallmann) has concluded that under normal pool recirculation and design conditions, a maximum bathing load limit of one bather per 35 to 45 sq. ft. of pool area will result in safe bacteriological conditions with adequate chlorine residuals. In the light of experience, these figures seem reasonable for swimming pools which are of ordinary dimensions. The area per bather is greater than provided for under the design requirements set under "Proportioning Pool Area to Expected Load", Section VI.

XXVIII. Operating Control

A. Trained Operators: Each swimming pool should be operated under the close supervision of a well trained operator with common sense and good judgment.

B. Tests for Excess Chlorine: At any pool where chlorine, hypochlorite of lime or other chlorine compound is used for disinfection, the operator must be supplied with a proper outfit for making the orthotolidin test for excess chlorine and with permanent standards showing maximum and minumum permissible chlorine in the water.

Tests for excess chlorine in the water shall be made as frequently during the day as experience proves to be necessary to maintain adequate residuals.

C. Tests for Acidity: At any pool where alum or sulphate of alumina is used or where artificial alkalinity is added to the water, the pool operator must be equipped with a hydrogen ion testing outfit and must take the hydrogen ion tests on the water every day the pool is in use, and more often if necessary.

D. Operating Records: Every pool operator must be supplied with a proper note book or with blank forms on which shall be recorded every day the number of persons using the pool, peak bathing loads handled, the volume of new water added, the temperature of the water, and the temperature of the air. Whenever a pool is used by both males and females the number of each and whether adults or children should also be recorded. At all pools where artificial circulation, filtration, or any chemical treatment is used, a full daily record must also be kept of the actual time pumps and filters are in operation, of the time each filter is washed or cleaned, of the time and amount of each chemical used or added, of the time the bottom and sides of the pool are cleaned, and the results of all hydrogen ion, excess chlorine, or other tests.

OUTDOOR BATHING PLACES

XXIX. Definition

Under this heading are considered bathing places along small streams, rivers, lakes, and tidal waters. Fill and draw and recirculation bathing pools readily subject to artificial purification or to constant replenishment with uncontaminated water are not included.

XXX. Sources of Pollution

In a swimming pool whose water is derived from a public or other supply of unquestioned quality, it may be assumed that the presence of organisms of the coli-aerogenes group indicates pollution by human sewage particles. The presence of such bacteria in outdoor bathing places, however, may be due to the wash from cultivated fields, animals, and generally harmless contamination. Routine bacteriological tests do not differentiate between harmful and harmless contamination in such cases. Harmful contamination may be caused by sewage from boats, individual dwellings, hotels, factories, or other establishments, public sewerage systems, refuse dumping, and bathers themselves.

XXXI. Flowing-Through Bathing Pools Along Small Streams

The use of small natural or dammed-up pools along small streams by large numbers of bathers is not recommended unless disinfection is provided, as discussed in the following section. Where such pools are proposed to be used, and will be dependent upon the natural stream flow for cleansing and dilution, it should be ascertained that there is a constant and appreciable overflow of water past the dam under all weather conditions when the pool is to be used. Any small pool patronized by a number of bathers is certain to show bacteriological pollution in considerable amounts unless disinfection is provided. While no specific amount of diluting water for such pools can be recommended, it is probably fair to say that less than 500 gallons per bather per day is too small a diluting volume without disinfection.

In New York state, the so-called Becker formula has been used as a practical guide in passing on necessary volumes of diluting water. This formula is $Q = 6.25\ T$ where $Q =$ quantity of water per bather and $T =$ the replacement period in hours. For example, if the flow is such as to replace the pool volume in 8 hours, $Q = 400$ and the number of bathers permitted in 8 hours would be the capacity of the pool divided by 400. When the replacement period is 12 hours, 900 gallons per bather are required by this formula.

Whether or not disinfection is employed, every effort should be made to eliminate all sources of sewage pollution on small streams or ponds used for bathing and careful sanitary surveys of watersheds are recommended. It is, of course, desirable that bathing be limited to relatively clear bodies of water and that muddy bottoms which will result in turbid water be avoided.

XXXII. Disinfection of Small Flowing-Through Bathing Pools

Disinfection is desirable to counteract pollution introduced by bathers. Hypochlorite in solution may be added to the pool inlet or at various points over the pool area. Chlorination of the pool inlet may be continuous. Several applications of disinfectant over the pool area during the bathing period are usually preferable to one application. Even with disinfection, the same governing factors should be considered in arriving at maximum bathing loads in small outdoor pools as presented under "Swimming Pools" (Section VI and XXVII), and also the same limits for chlorine residuals are recommended as for swimming pools. Disinfection of large bodies of water is discussed in the following section.

XXXIII. Disinfection of Large Bodies of Water

The disinfection of relatively large bodies of water by use of a chloroboat, so-called, has been used with apparently some success in a few scattered instances. In some locations, bathing areas several acres in area have been disinfected satisfactorily by the use of extensive piping systems along the water bottom either for distribution of chlorine disinfecting solutions or for distribution of large amounts of pumped water drawn from the bathing area and disinfected in the pump suction with chlorine or chlorine and ammonia in what is practically a recirculation system. Where such disinfection is feasible, the same contents of chlorine and chloramine residuals are recommended as have been proposed for swimming pools. Chlorine and ammonia are undoubtedly more practical of application for large outdoor bathing areas than chlorine alone due to the greater persistence of the chloramines in the water. This probably outweighs the disadvantage of the slower disinfecting action of the chloramines as compared with chlorine. While the possibilities of disinfection methods deserve consideration, unless the future brings forth further developments in the way of attempt to establish bacteriological standards for outdoor bathing places, it appears that emphasis will be laid on the reduction of pollution of outdoor bathing areas rather than on attempt to counteract such pollution by disinfection of bathing waters. The use of disinfecting agencies, however, may be developed particularly to guard against dangers from pollution by bathers themselves in those densely populated bathing areas which are not

subject to major water changes through the action of tides and currents.

XXXIV. Collection of Samples for Outdoor Bathing Places

Analyses of samples of bathing waters intelligently interpreted are of great value but full consideration should be given to the conditions under which samples are collected and the conditions which may exist at other times. The replenishment of bathing water by stream flow, by tidal action, and by wind and temperature current, the contamination introduced by bathers themselves and the intermittency of various sources of sewage pollution, are all of importance. In considering dangers from sewage pollution of bathing areas, it is well to emphasize that time is a factor of great importance. The hazard from a relatively small amount of sewage pollution in close proximity to a bathing area is far greater than a large amount at a considerable distance.

XXXV. Bacteriological Classification of Bathing Waters

In the collection of samples from bathing waters in connection with a scheme of relative classification of bathing waters which is subsequently presented, it is suggested that in arriving at a coli-aerogenes count on samples, a simple procedure is to run 4 or 5 dilutions from 10 c.c. down on each sample, in accordance with the expected amount of pollution and to assume 1 B.coli originally present in the greatest dilution to give a positive test. For example, positive in 10 c.c. and 1 c.c. and negative in 0.1 and 0.01 c.c. would be called 100 B.coli per 100 c.c. Where so called anomalous results are occasionally obtained, such as a sample showing positive in 10 c.c., negative in 1 c.c., and positive in 0.1 c.c., it is suggested that the greatest dilution result be recessed to the next, which in the case illustrated would give 100 B. coli per 100 c.c. This is an arbitrary method of computation, open to some mathematical objections, but it is simple and is satisfactory for all practical purposes. On the basis of experience where a large number of samples has been handled, presumptive tests on lactose broth may be considered sufficient evidence of the presence of B. coli, the resulting error as against complete confirmation according to standard methods of water analysis being slight.

XXXVI. Relative Classification of Bathing Areas Recommended

In passing on waters of outdoor bathing places, three aids are available: (1) the results of chemical analyses of the water; (2) the results of bacteriological analyses of the water; and (3) information obtained by a sanitary survey of sources of pollution, flow currents, etc. Chemical analyses may in some cases be of value but are not ordinarily delicate enough tests.

It is not considered practicable or desirable to recommend any absolute standard of safety for the waters of outdoor bathing places on any of the three above bases. The arbitrary wholesale condemnation of bathing beaches representing large capital investments is unwarranted without definite epidemiological evidence. A relative scheme of classification of outdoor bathing places appears to offer the most promising program for public health workers to follow. Due to the difference in local conditions surrounding bathing in tidal waters, large and small lakes, and large and small streams, the degrees of classification of the bathing waters in any particular region may of necessity be varied.

In one state, a classification survey of the shore waters was carried out. The entire shore line was divided into sampling stations about 1,000 feet apart and samples for bacteriological analysis were collected in from 2 to 6 feet of water at high, low, and half ebb, and half flood tides at each station. The results were averaged and adjoining stations combined into sections on the basis of the sanitary survey information. The analytical classification for each section was made by averaging the averages for the included stations. The sections were then classified on the basis of the analyses as follows:

	Average B.coli per 100 c.c.
Class A	0 - 50
Class B	51 - 500
Class C	501 -1000
Class D	Over 1000

These same sections were also classified in classes A, B, C, and D on the basis of sanitary survey information as to sewer outlets, float studies, etc., and final classifications were based on both the analysis and sanitary survey classifications. In the sanitary survey classifications, class A was considered good; class D very poor; and the two intermediate classes ranged from doubtful to poor. Close correlation was

obtained between the analysis and sanitary survey classifications.

Proposed bacteriological standards by various agencies have seemed to hit mainly upon two widely divergent limits for standards of acceptability for bathing waters, one of which is 50 B.coli per 100 c.c. and the other of which is 1,000 B. coli per 100 c.c. It is perhaps reasonable to conclude that, subject to interpretation of analytical studies from proper angles, waters better than the lower limit (1,000 B.coli per 100 c.c.) are fairly acceptable. Both these lines of demarkation are drawn in the classification scheme just presented and the committee recommends the use of this classification scheme unless local conditions make some other classification scheme preferable. If it is desired to set up any intermediate classifications, any classification such as "A" can be broken up into "A + " and "A - ". The interpretation of areas falling into classes B, C, and D as to whether these areas can be considered good, doubtful, poor, or very poor, must for the present be left with the interested state health department or other agency concerned. As further information is gained from the classification of areas, more definite conclusions may be reached. It is emphasized again that final classifications should not be made upon the basis of bacteriological analysis alone, but should depend largely on correlative sanitary survey information. Allowances should be made and distinctions drawn as to pollution introduced by large bathing loads at outdoor bathing places and pollution derived from sewer discharges or other sources.

The committee feels that the health board or department of each state should be the guiding agency for state-wide studies of outdoor bathing areas, with the assistance of community and district health units where practicable. Information obtained as a result of classification surveys of bathing waters should be in the hands of public health workers, to enable them to furnish intelligent answers to inquiries on the part of the public. While data of this type should be released advisedly so as not to cause unwarranted depreciation of property values near bathing areas, it should serve to acquaint the public with danger spots caused by uncontrolled discharge of sewage and to promote the betterment of health conditions by installation of sewage treatment where necessary for the protection of bathing waters. The recent studies and recommendations of the Tri-State Pollution Commission (New York, New Jersey, and Connecticut) point out what may be done in the way of specifying degrees of treatment for discharge of sewage into waters allocated for recreational purposes.

XXXVII. Sanitary Appurtenances at Outdoor Bathing Places

Attention is directed to the need for proper sanitary appurtenances at outdoor bathing places. The remarks in Section XII and XIII under "Swimming Pools" with regard to dressing rooms, showers, toilets, and lavatory accomodations, are also pertinent as to outdoor bathing places.

SWIMMING POOLS-BATHING BEACHES -- REGULATIONS OF LOUISIANA SANITARY CODE.

DEFINITIONS: For the purposes of these regulations the following terms are defined:

ARTIFICIAL SWIMMING POOL: Any outdoor or indoor pool which is entirely of artificial construction and provided with a controlled water supply.

BATHING PLACE: Any body of water together with buildings and appurtenances in connection therewith, used collectively by numbers of persons for swimming or recreational bathing.

PARTLY ARTIFICIAL SWIMMING POOL: Any pool formed artificially from a natural body of water.

SWIMMING POOL: Any artificial or partly artificial pool, together with buildings and appurtenances in connection therewith, used for swimming or recreational bathing by the public or groups of persons as members of clubs, associations or other organizations.

TURNOVER: The ratio of the volume of clean water entering the pool in twenty-four (24) hours to the total pool volume.

GENERAL PROVISIONS: The provisions of these regulations shall apply throughout the State and shall affect any person or persons, groups, firm, corporation, partnership, institution, association, municipality, parish or other body, providing or operating any swimming pool or bathing place.

PLANS AND SPECIFICATIONS: Plans and specifications for the construction of new swimming pools, accompanied by such data as may be required, shall be submitted in duplicate to the State Board of Health. No pool shall be constructed until a letter approving the plans and specifications has been received. No deviation from said plans and specifications shall be made unless the proposed changes have been submitted to and received the written

approval of the State Board of Health. No change shall be made in existing swimming pools or appurtenances thereof, until the plans and specifications therefor shall first have been submitted to and received the written approval of the State Board of Health.

BACTERIAL QUALITY OF ARTIFICIAL SWIMMING POOL WATER: Not more than fifteen (15%) per cent of the samples covering any considerable period of time shall contain more than two hundred (200) bacteria per ml. or shall show positive test (confirmed) for the coli-aerogenes group, in any of five ten ml. portions of water at times when the pool is in use. All primary fermentation tubes showing gas should be confirmed.

CHEMICAL AND PHYSICAL QUALITY OF ARTIFICIAL SWIMMING POOL WATER: (a) Excess Chlorine: Whenever chlorine, calcium hypochlorite, or other chlorine compounds, without the use of ammonia, are used for swimming pool disinfection, the amount of available or excess chlorine in the water at all times when the pool is in use shall not be less than 0.4 p.p.m. Whenever chlorine or chlorine compounds are used with ammonia, the amount of available or excess chloramine shall not be less than 0.7 p.p.m. or more than 1.0 p.p.m. (b) Acidity-Alkalinity: Whenever alum or sulphate of alumina is used during purification or repurification of swimming pool waters, the water at all times when pool is in use shall show an alkaline reaction. The hydrogen ion content of the pool water shall not fall below 7.0. (c) Clearness: At all times when the pool is in use the water shall be sufficiently clear to permit a black disk 6 inches in diameter on a white field, when placed on the bottom of the pool at the deepest point, to be clearly visible from the side walks of the pool at all distances up to 10 yards measured from a line drawn across the pool through said disk. (d) Temperatures: The water in any swimming pool should not be artificially heated to a temperature above 78°F. The temperature of the air at any artificially heated swimming pool must not be permitted to become more than 8°F. warmer nor more than 2°F. colder than the water in the pool, at any time when the pool is in use.

ARTIFICIAL SWIMMING POOLS: The following regulations shall apply to artificial swimming pools.

ARRANGEMENT: The pool shall not be less than 60 feet in length. There shall be an adequate area of deep and shallow water. There shall be no sudden changes of bottom slope within the shallow depths of water. The slope of the bottom of any part of the pool where the water is less than 6 feet deep shall not be more than one foot in each fifteen (15) feet.

MARKING: The one foot increment of depths should be marked on the sides of the pool.

INLETS AND OUTLETS: A sufficient number of inlets shall be provided and so located as to provide adequate circulation through the pool. A sufficient number of outlets shall be provided to permit complete draining of the pool in four hours. Openings of the outlets shall be at least four times the size of the discharge pipe and covered with a suitable grating.

SCUM GUTTER: Scum gutters shall extend completely around the pool. The scum gutter shall be so designed to be easily cleanable and so that material entering them will not be washed out by sudden surge of entering water, and that dangers of bathers catching arms or feet in them be reduced to a minimum. A sufficient number of drainage outlets shall be provided to carry away water entering the scum gutter during surface flushing.

STEPS, LADDERS AND STEP HOLES: A sufficient number of steps or stairways shall be provided and so constructed to minimize dangers of accidents.

GENERAL CONSTRUCTION: The pool walls shall be vertical and the walls and floors shall be constructed with white tile or light colored cement or other impervious material. The surfaces shall be smooth and permit easy cleaning.

RUNWAYS OR SIDEWALKS: Runways or sidewalks at least four feet wide and extending completely around the pool shall be provided. They shall be properly drained, easily cleanable and constructed of a non-slip material.

VISITORS' GALLERY: There shall be an absolute separation of the space used by spectators from that used by bathers. There shall be no means by which bathers can enter space reserved for spectators or vice versa. Visitors' quarters must have a separate entrance. Galleries for spectators shall not overhang any portion of the pool surface. Floor and foot rail of the gallery shall be of tight construction to prevent dirt which is tracked in from getting into the pool. The gallery floor should slope to a drain and should be flushed down with hose regularly. Seats in galleries should be of non-absorbent construction to permit washing. The drainage from the spectators' area should be in no case allowed to drain upon the area used exclusively by bathers. A curb or other arrangement should be used to prevent litter and dirt from being kicked or scuffed by spectators into the pool or pool area.

DRESSING ROOMS: Separate dressing rooms should be provided for each sex. Floor shall be well drained, impervious to moisture and constructed of non-slip material. Walls and partitions shall be constructed of smooth, impervious material, without open cracks or joints. Screens shall be placed at the entrances and exits of dressing rooms to break the line of sight.

SHOWERS, TOILETS AND LAVATORIES: An adequate number and type of showers, toilets and lavatories shall be provided for both sexes. Urinals and toilets shall be so located that bathers will use them before entering the showers on their way to the swimming pool. All equipment shall be properly maintained. Sewage shall be disposed of in a manner conforming to the provisions of this Code.

FOOT BATHS: A foot bath shall be provided at every exit from the dressing rooms to the pools. The foot bath shall contain a fungicidal solution, in adequate concentration, as a protection against "ringworm" infection, and should be of a sufficient size to insure contact with the bathers' feet as they pass to the pool

DISINFECTION: Disinfection shall be employed where there is an appreciable bathing load in the swimming pool. The disinfection of the water shall be continuous and when chlorine alone is used, the water shall contain at least 0.4 parts per million residual chlorine; or 0.7 parts per million residual chlorine when chlorine in the presence of ammonia is used, as determined by the orthotolidine test.

TURNOVER: The turnover of clean water entering the pool daily shall not be less than two. The term "clean water" shall mean water from an approved source of water taken from the pool and returned after effective filtration and disinfection.

INTERCONNECTIONS: There shall be no physical connection between a potable public or private water supply system and a pool structure at a point below the maximum flow line of the pool, or to the recirculation system of the swimming pool, unless such physical connection is so installed and operated that no pool water can be discharged or syphoned into a potable water supply system.

CLEANLINESS: The bottom and sides of pools shall be kept reasonably free from sediment and visible dirt. Visible scum of floating matter on the surface of the pool shall be removed at least once each day.

BATHING LOAD: An adequate pool area shall be provided in the pool to prevent overcrowding. The total number of bathers permitted to use the pool during any one period shall not exceed one person for every five hundred (500) gallons of water in the pool. If the bacteriological analyses of the pool water indicates that the pool is being overcrowded, the total number of bathers allowed to use the pool during any one period shall be reduced until safe load limits are established.

PARTLY ARTIFICIAL SWIMMING POOLS AND BATHING PLACES: No partly artificial swimming pool or bathing place shall be maintained or operated on a natural body of water when such water is determined by the State Board of Health to be so polluted as to constitute a menace to health if used for bathing.

The local health officer shall determine the maximum number of bathers who may utilize a partly artificial swimming pool or bathing place and the quantity of fresh water which must be discharged into any swimming pool in any given period of time; the treatment, if any, the water in the pool or bathing place shall receive; and the number of dressing rooms, showers, toilets and/or any other appurtenances that shall be provided to maintain sanitary conditions at the pool or bathing place.

LIGHTING: A complete system of artificial lighting shall be provided for all pools, bathing beaches, bath houses, and dressing rooms which are to be used at night. Lighting shall be sufficient to light all parts of bathing areas.

VENTILATION: All indoor pools and all bath houses, dressing rooms, shower rooms and toilets at both indoor and outdoor pools and bathing places shall be properly ventilated. Ventilation of indoor pools shall be so designed that direct draft will not blow on bathers.

DIVING TOWERS, SPRING BOARDS AND FLOATS: Diving towers, when provided, shall be rigidly constructed and properly anchored to the bottom with sufficient bracing to insure stability under the heaviest possible load.

Floats or fixed platforms in the water shall be constructed with an air space of at least one (1) foot beneath. All braces, struts, etc., shall be designed to prevent entanglement or trapping of bathers beneath the platform.

At least thirteen (13) feet free and unobstructed headroom must be provided above diving boards. A safe depth of water shall be provided for diving from various elevations. No diving board or platform shall be more than ten (10) feet above water level.

Spring boards, diving platforms and floats shall be covered with non-slip material.

EMERGENCY EQUIPMENT: Pole-hocks, ropes, buoys and other necessary life saving equipment shall be provided and readily accessible at all pools and bathing places. A first-aid kit completely equipped shall be provided for emergency uses at all pools and bathing places.

SUPERVISION OF BATHERS: One or more life guards shall be on duty at swimming pools and bathing places during all bathing hours. The life guards shall be capable swimmers, competent in life saving methods and in methods of artificial resuscitation. The life guards shall be in full charge of bathing and have authority to enforce all rules of safety and sanitation. An attendant shall be on duty at the shower room or entrance to the swimming pool or bathing places to inspect all bathers for skin diseases, open lesions, etc., and to ensure that a proper cleansing bath has been taken. At least one trained first-aider shall be among the pool personnel.

PERSONAL REGULATIONS: All persons using swimming pool shall be required to take a cleansing shower bath in the nude, using soap and water and thoroughly rinsing off all soap suds before entering the pool. All bathers shall be required to rinse their feet in the solution in the foot bath before entering the pool.

A bather leaving the pool for any reason shall take a foot bath before returning. A bather leaving the pool to use the toilet shall be required to take a second cleansing bath before returning.

All bathers shall be instructed to use the toilet and particularly to empty the bladder before taking cleansing bath and entering the pool.

Any person having skin disease, sore or inflamed eyes, cold, nasal or ear discharges, or any communicable disease shall be excluded from a public swimming pool.

Spitting, spouting of water, blowing the nose, etc., in the pool is strictly prohibited. No boisterous or rough play, except supervised water sports, shall be permitted in the pools, on the runways, diving boards, floats, platforms, or in dressing rooms, showers, etc.

POSTING REGULATIONS: Placards reciting the above personal regulations shall be posted conspicuously at the pool or enclosure and in the dressing room and offices of all pools and bathing places.

SKETCH SHOWING SANITARY AND INSANITARY METHODS OF INSTALLATION FOR CERTAIN TYPES OF WELLS

ILLUSTRATED 2"A" TO 2"D"

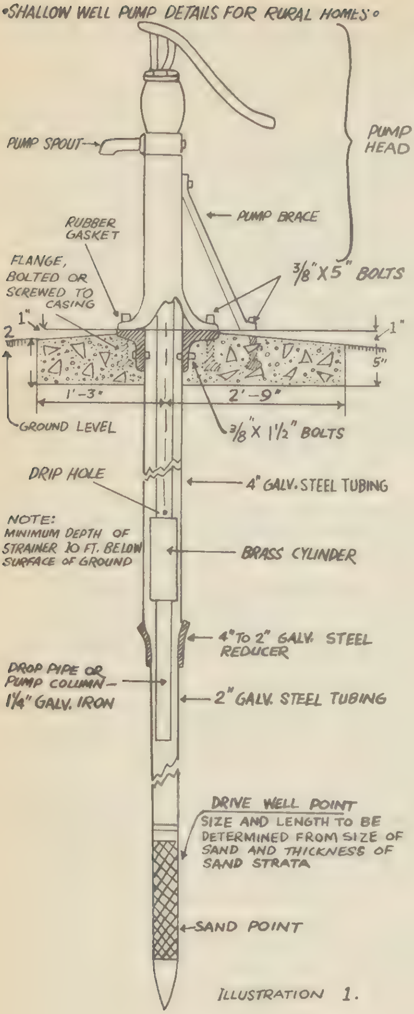
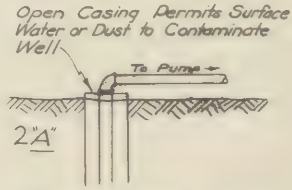
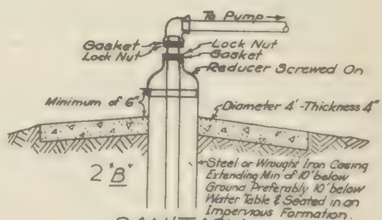


ILLUSTRATION 1.

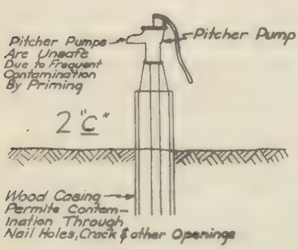


INSANITARY



SANITARY

Installation for Motor Driven Pumps



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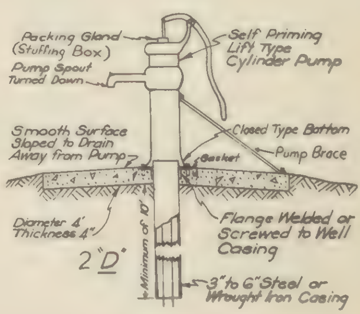
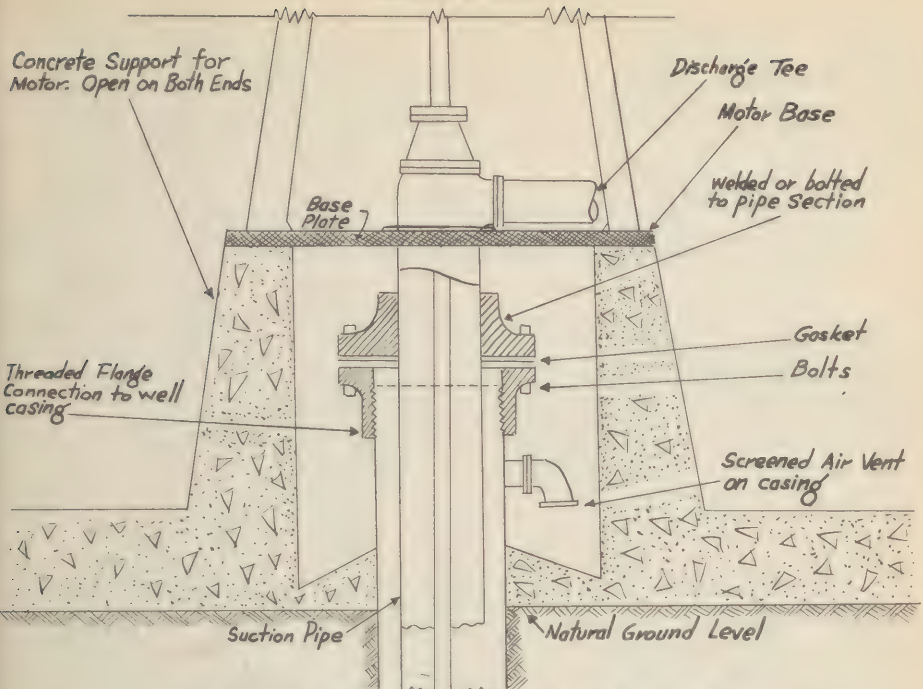


SANITARY

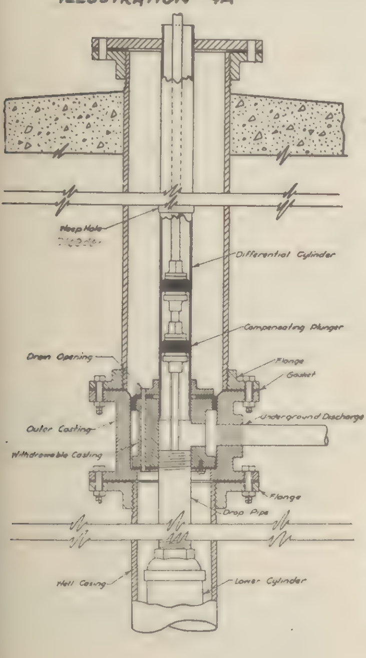
Installation for Hand Pumps

ILLUSTRATION. 3



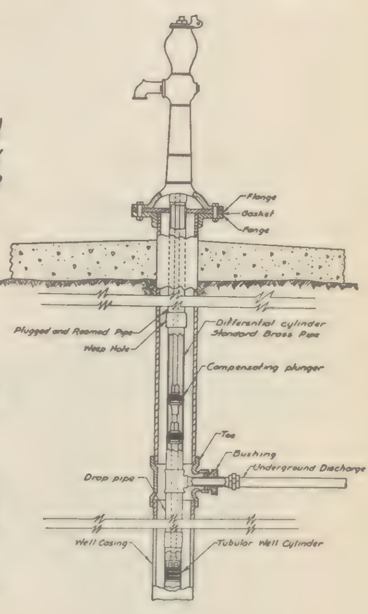
• CASING HEAD CONSTRUCTION FOR DRILLED WELL •

ILLUSTRATION 4A



Properly Constructed Drilled Well, Showing Underground Discharge Arrangement

ILLUSTRATION 4B



Drilled Well Using Standard Tee and Underground Arrangement to Discharge Water below Frost Line

ILLUSTRATION 5

PLAN FOR CONSTRUCTION OR REBUILDING BORED WELLS

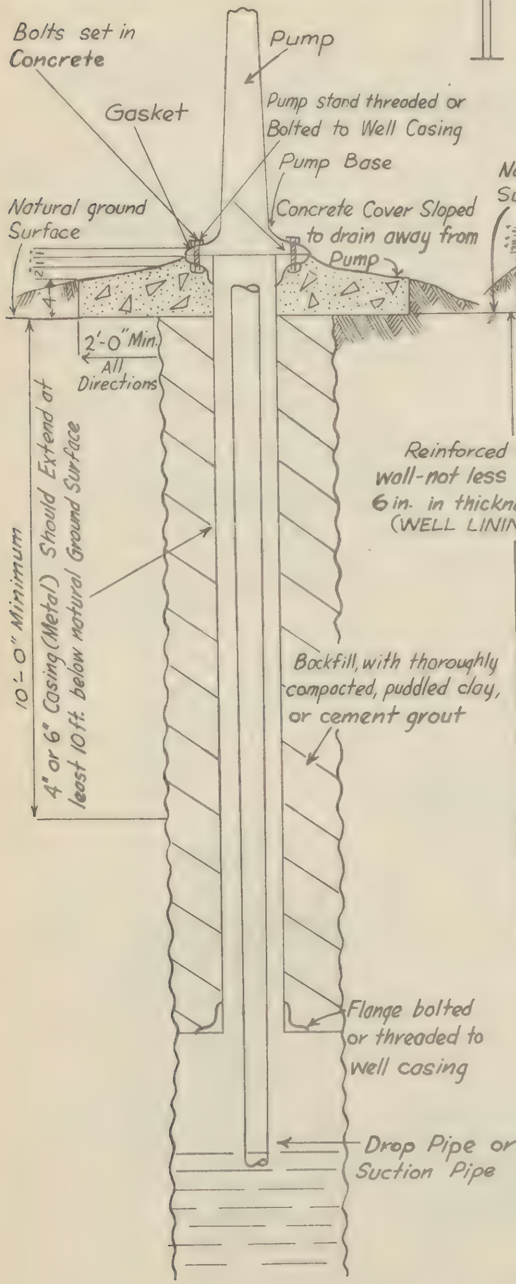


ILLUSTRATION 6

PLAN FOR CONSTRUCTION OR REBUILDING DUG WELLS

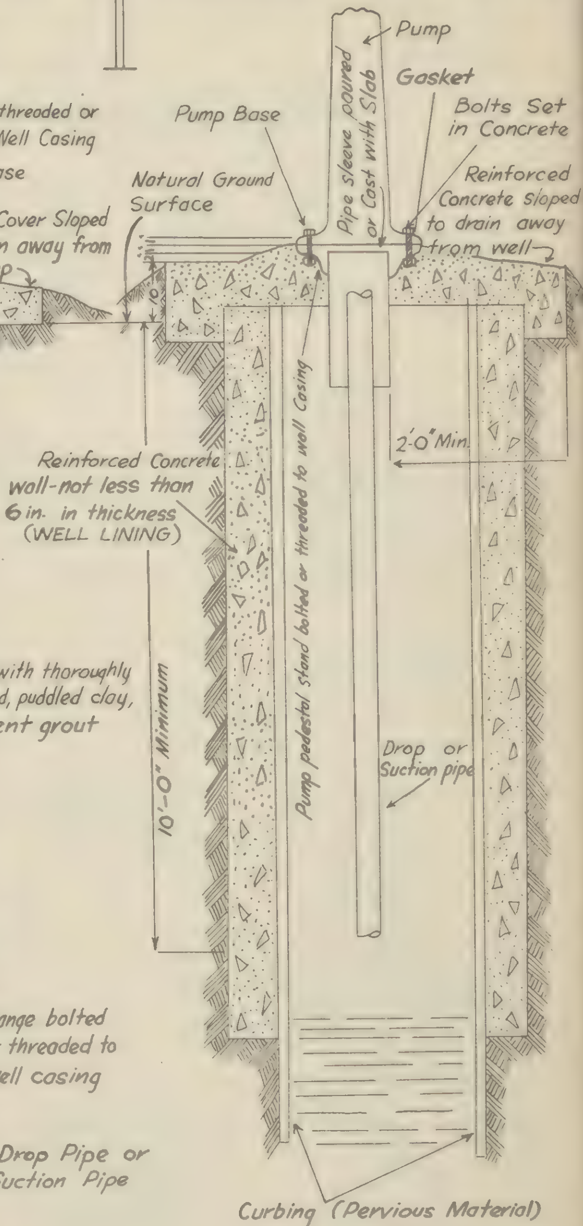
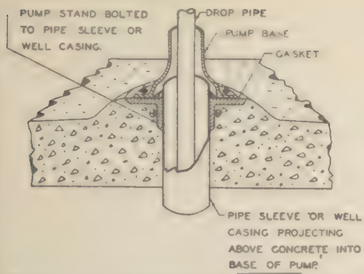
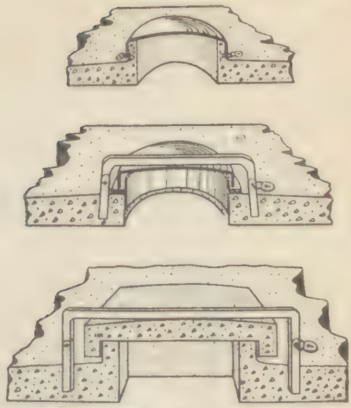


ILLUSTRATION 7.



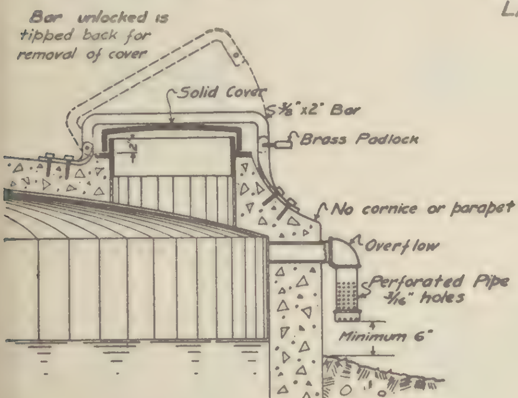
DETAIL OF CONSTRUCTION AT BASE OF PUMP

ILLUSTRATION 8.



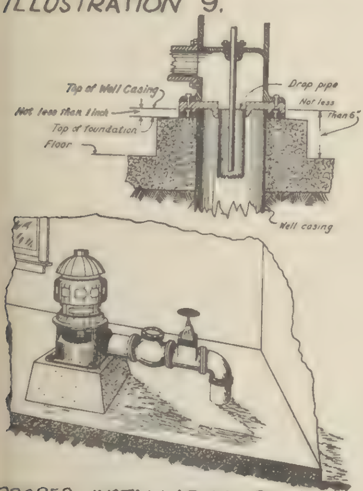
MANHOLE COVERS OF THE OVER-LAPPING TYPE

ILLUSTRATION 8-A



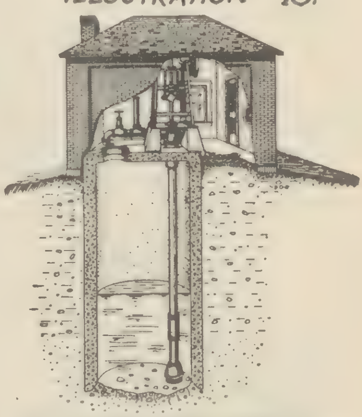
CORRECT TYPE OF MANHOLE OPENING AND COVER FOR DUG WELL OR SURFACE RESERVOIR

ILLUSTRATION 9.



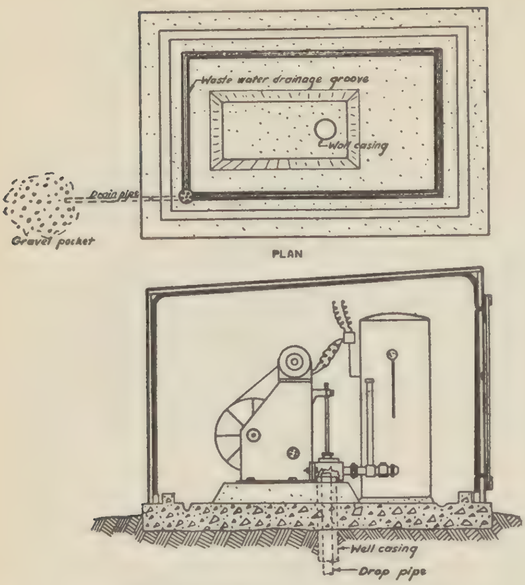
PROPER INSTALLATION OF A VERTICAL TURBINE PUMP

ILLUSTRATION 10.



PROPERLY CONSTRUCTED DUG WELL AND PUMP ROOM

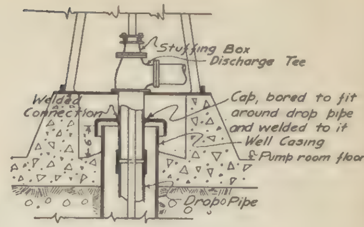
ILLUSTRATION 11



SECTION

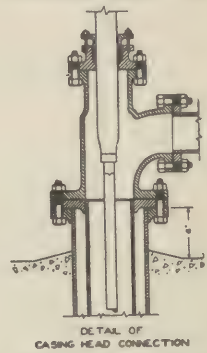
PLAN AND SECTION OF INSULATED PUMP HOUSE

ILLUSTRATION 12



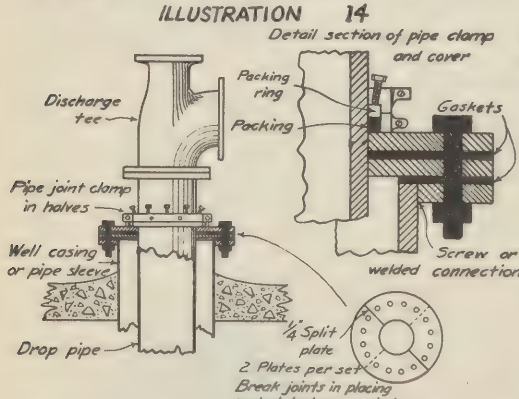
CASING HEAD CONSTRUCTION FOR DRILLED WELL

ILLUSTRATION 13



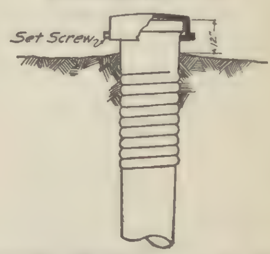
DETAILS OF CASING HEAD CONNECTION WITH DROP PIPE

ILLUSTRATION 14



ARRANGEMENT OF CLOSING ANNULAR SPACE BETWEEN DROP PIPE AND CASING HEAD OR PIPE SLEEVE BY MEANS OF A REMOVABLE STUFFING BOX AND OVERLAPPING CAP.

ILLUSTRATION 15



PROPERLY INSTALLED VALVE BOX ON SUCTION LINE

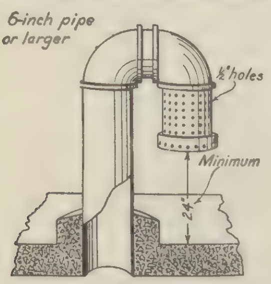
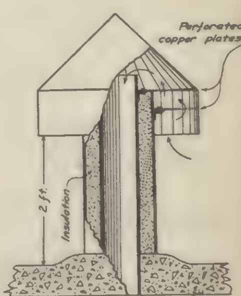


ILLUSTRATION 16

ILLUSTRATION 17



SUITABLE TYPES OF VENTS

ILLUSTRATION 18

CONSTRUCTION FOR SPRINGS

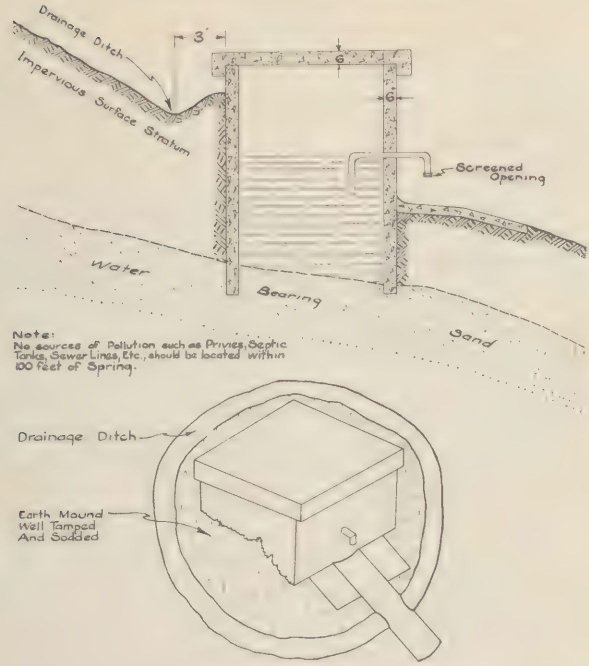
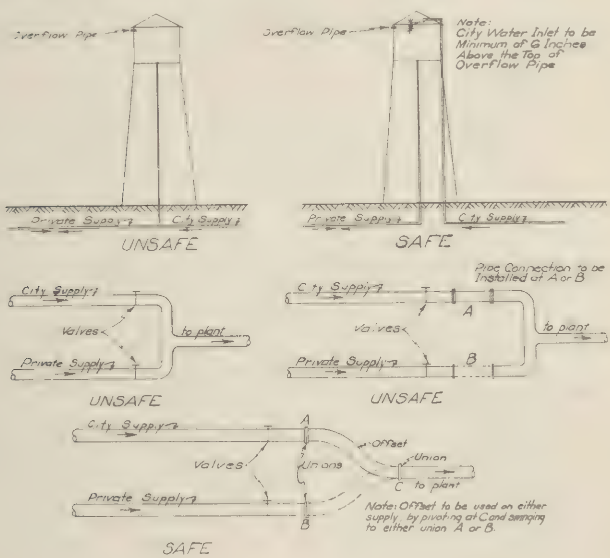


ILLUSTRATION 19

SKETCH SHOWING SAFE AND UNSAFE METHODS OF MAKING CONNECTIONS BETWEEN CITY WATER SUPPLY AND PRIVATE WATER SUPPLIES



Rural Water Supply

The sources of water may be classified into three groups:

(1) Rain water (usually collected by cisterns)
(2) Surface water (rivers, lakes, ponds)
(3) Ground water (wells and springs).

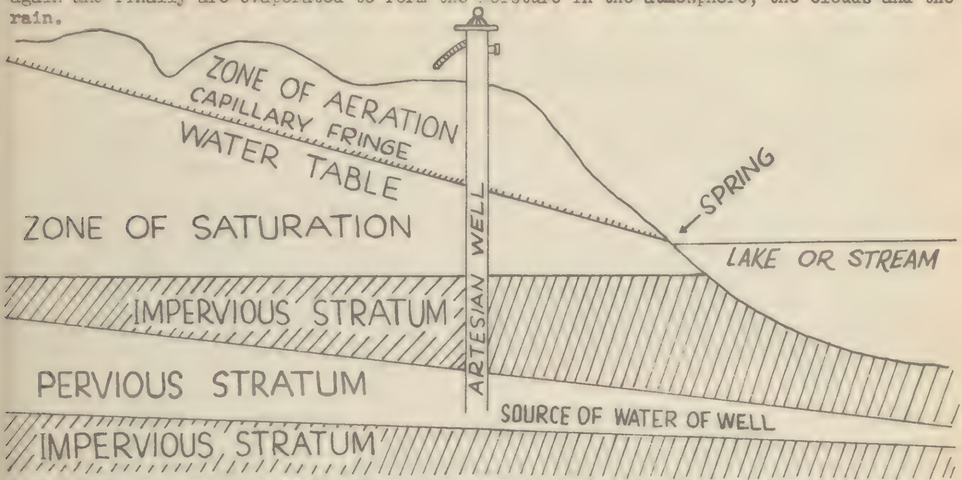
In rural areas, rain water and ground water are the usual sources of supply, since these sources are the less disposed to pollution or contamination than surface water. Surface water is greatly purified as it percolates through fine sandy soil. This is nature's process of filtration; the organic matter is oxidized and the bacteria are largely strained out. The soil can take care of a large amount of pollution, and, if not overburdened, or if it has no cracks or crevices through which surface water may run unfiltered, the ground water may be entirely free of objectionable organic substances and bacteria. In passing through the soil the water takes up a rather large amount of carbon dioxide, which is set free by organic decomposition. This water, thus made acid (since CO_2 in water forms carbonic acid), has a greater solvent action for lime and other mineral constituents, so that ground water is apt to be harder than surface water, and to contain a larger amount of dissolved inorganic substances. In deeper waters the solvent action is favored by increased contact with geological formations, so that deep wells and artesian waters are frequently unfit for domestic use on account of the large amount of lime, iron, salt, and other inorganic impurities which they contain.

WATER CYCLE

It might be well to follow the water through its cycle of movement in order to gain a more vivid picture of its interesting course.

1) Moisture in atmosphere is precipitated to form rain
2) Rain water runs along surface of the earth
   a) Part runs into lakes and streams
   b) Part is evaporated
   c) Part soaks into the ground
      (1) Part of the ground water is taken up by vegetation and transferred by means of plants into the atmosphere. (2) Part of the ground water passes easily through the upper layers of the earth which is less dense and has a certain amount of air (and therefore oxygen) in its porous structure. This is known as the "zone of aeration", and in it organic material is oxidized by bacterial action and some physical, chemical and electrical action, with final mineralization of the decomposed organic matter. At the same time the porous nature of the soil acts as a natural filter of bacteria.
      (a) Zone of aeration is kept moist by water that is adsorbed to the particles of earth. This water is known as "Pellicular Water".
      (b) Other water which continues to pass downward is called "Gravity Water". As the water continues to pass downward the ground becomes denser and more impervious and therefore the water accumulates and saturates the ground. This saturated layer is known as the "Zone of Saturation". Between the zone of saturation and zone of aeration is a fringe where water is held by capillary action. This is called the "Capillary Fringe" and corresponds to a narrow stratum just above the "Water Table". The Water Table is the stratum just below the Capillary Fringe and forming the upper layer of the Zone of Saturation where the water ceased to pass downward and is directed instead along a horizontal plane, forming a more or less continuous bed of water in the porous stratum in which it is found. This water table underlies practically all of the earth's surface. Sometimes it is close to the surface and sometimes it is deep, depending upon such factors as the amount of rain, types of stratum in the earth and others. The water level more or less conforms to the slope of the earth's surface. Where the water table stratum emerges to the surface of the earth due to geological formation, "Springs" occur. Where the bed of streams are in the saturated zone, the streams receive water from it. The water level is kept from fluctuating by discharging as springs or into beds of streams or lakes. A well is merely a hole dug deep enough to reach the zone of saturation. The height of water in the well is determined by the level of the water table.

The water cycle is now complete. Well water and spring water find their way from the ground again and finally are evaporated to form the moisture in the atmosphere, the clouds and the rain.



RAIN WATER: Rain water is really "Distilled Water", that is, it is water that has been vaporized and then condensed. The process of distillation is one of the best known methods for purifying liquids of all kinds. Rain water, therefore, should approach nearer to absolute purity than any other kind of natural water. However, it receives impurities from the moment it condenses, for each droplet of mist is formed about a particle of dust in the air. The rain drop further absorbs gases; near the sea-coast it dissolves suspended salts. As it drops through the air it collects a large amount of the "dirt" floating in the lower strata of the atmosphere. If collected from a clean impervious surface such as a good roof on a farm house, it is a very pure natural water. The use of rain water, however, for drinking purposes has met with little favor by sanitarians because it is so frequently collected and stored in such careless manner that it is subject to pollution.

Because rain water is soft, it recommends itself for use in the laundry, and the absence of lime salts renders it desirable for cooking. On the whole, however, it is not considered as practicable as a good ground or surface water for general domestic supply.

Usually it is advisable to filter rain water collected from roofs of buildings, especially if situated in towns or near dusty roads.

Roughly, the amount of water provided by rain will be calculated by multiplying the area of the receiving surface in square feet by half the rainfall in inches, measured by a rain-gage; the result will be in gallons. Thus, one inch of rain on a house roof 20 x 20 feet would be about two hundred gallons. With a rainfall of forty inches per annum, the yield would amount to 8,000 gallons.

The points of prime importance in the collection and storage of rain water for domestic purposes are:

1) The material and care of the surface upon which it is caught
2) The separation of the first flow, which contains most of the gross impurities
3) The location and construction of the storage cistern.

Tanks of wood serve well, provided they are kept full. Great fluctuation of the water line causes tank to fall out of repair. Rain water attacks iron, lead, zinc, and other metals; therefore, metal cisterns and delivery pipes should be coated with a good asphaltum paint. Lead cisterns or pipes should under <u>no</u> circumstances be used. Frequent cleansing of cistern is important.

Rain water contains the following gases:

1) Nitrogen
2) Oxygen
3) Carbon dioxide
4) Ammonia.

The principle inorganic constituents are:

1) Sodium Chloride (comes from sea-spray carried in wind)

2) Nitric acid and nitrates
3) Sulphuric acid and sulphates (waste products of coal burning).

GROUND WATER: This is water which is taken from the ground by means of wells or that flows naturally from the ground such as springs. These are usually greatly purified waters due to natural filtration as they percolate through fine sandy soil. Where the ground is not porous the water may be dangerous for domestic use.

Were it not for the fact that many processes are constantly at work to prevent the accumulation of contamination underground, all contamination that may have reached the ground water since the beginning of time would still be present in it. The procurement of potable ground water for human use would therefore be absolutely impossible. Among the factors mentioned by Stiles and Crohurst as having a bearing upon the accumulation of bacteria are the hydrogen-ion concentration of the soil, the effect of drying because of changes in the level of the ground water, competition between bacteria, protozoan competition or the devouring by other organisms, temperature, the presence or absence of a food supply, the natural death rate of bacteria, the effect of capillarity, which may carry bacteria into the capillary fringe where they may die by drying, and the natural action of bacteria to seek an oxygen supply and hence accelerate the accumulation of the bacteria near the water table, where they may subsequently be unwatered by the lowering of the water table and be killed by drying.

The chief factors bearing upon the contamination of ground water supplies as related to location are:

1) Nature of earth formations with respect to the freedom with which water can move toward the well or spring, and also with respect to the character of soil and geological formations at the surface, such as porosity, uniformity, size of material, stratification, rock solution, channels, faults, and similar conditions which may affect the underground water.
2) Rate and direction of the movement of ground water as related to degree and direction of slope of land and the water table, and distance from source of contamination.
3) Mode of occurrence of ground water - whether water is obtained from zones near the water table or from artesian zones.
4) Rate of pumping used or anticipated.
5) Flooding and drainage.
6) Toilets, floor drains, and the like.
7) Pits.

A. CLASSIFICATION OF ROCKS (2)

Rocks may be classified with respect to their origin into three great classes - sedimentary rocks, igneous rocks, and metamorphic rocks. The markedly different sources of origin of these classes produce rocks of radically different character and hence considerable difference in their water-bearing properties.

Sedimentary rocks are derived from older rocks by weathering and erosion - as, for example, by the deposition of gravel, sand, silt, and clay, by the deposition of calcareous and siliceous remains of animals, as in most of the limestones, marls, and related rocks, or by the chemical deposition of substances precipitated from solution, as in much of the flint and chert, caliche and some other limestones, gypsum, and salt. Rocks of sedimentary origin include formations that are among our best water bearers - as, for example, gravel, sand, sandstone and creviced limestone.

Igneous rocks are produced by the cooling and solidification of molten masses of material from great depths below the surface, where the earth is very hot. These rocks differ widely in texture and water bearing properties. Most of the igneous rocks that are now at the surface were solidified far below the surface and were originally very compact and nearly impervious -- as, for example, unweathered granite. Water in quantities sufficient for well supplies occurs in such rocks largely in the joints and in the weathered surficial parts of the rocks. They are generally not profuse water-bearers. The lavas poured out upon the surface may, however, be so broken and vesicular that they will yeild water in great abundance -- as, for example, many of the basalts of the northwestern states and Hawaii. Upon weathering these extrusive rocks become more compact and less permeable.

Metamorphic rocks are produced by the marked alteration of other rocks, chiefly at great depths, through the agency of heat and pressure. The principal rocks of this class are quartzite, slate, marble, schist, and gneiss. The metamorphic rocks are generally compact and nearly impervious, and they yield only meager supplies of water, chiefly from their joints, crevices, and cleavage planes or from the surficial weathered parts of the rocks.

The most abundant sources of ground water may be obtained from: (1) Sand and gravel deposits (2) Sandstone rock and (3) Limestone formations.

The size, shape, and interrelations of the interstices in the rocks are of primary importance in determining the bacteriologic quality of the water that accumulates below the groundwater table and supplies the wells and springs, for they determine largely the rapidity with which water may pass through a formation and the ability of the formation to filter out pollution. Formations that exert great filtering action on water passing through them such as most formations of sand or sandstone, furnish the greatest protection against the transmission of pollution. On the other hand, formations that contain fissures and joints, large interstices, as in coarse, clean gravel, or solution channels, as in the creviced limestones, provide little filtering action and, moreover, may allow the water to move rapidly. Such formations may carry contamination long distances from the original sources.

One of the best formations to yield water in abundance is clean, coarse gravel. It possesses all the essential characteristics of an excellent water-bearing rock, for it absorbs water freely, stores water in great volume, and yields water freely to wells. In this material there is essentially no water in the individual pieces of rock, but because the openings between the pieces are large and connected with one another water may move freely through it. Little filtering action on the water is provided, and, hence, contamination can move through the gravel readily.

If the void space of gravel is filled with material of smaller size, such as sand, the water moves less freely than in the clean, coarse gravel and because the voids are smaller, the filtering action is correspondingly increased; therefore, great protection against the transmission of contamination is afforded. Obviously, a formation composed of sand alone provides maximum filtering action, and clean sands are classed in the group of rocks that afford the greatest safety from contamination. However, if the individual sand grains are very small the resistance to the movement of the water may be so great that the formation will not yield much water. A true clay has extremely small interstices, and even though its porosity may be greater than that of many deposits of sand or gravel, little or no water moves through it, and it is classed as non-water-bearing and impervious. As clay resists the movement of water, it also prevents the passage of bacteria, and hence it is effective in protecting under-lying water-bearing beds from pollution and is an especially favorable material in which to seat a well casing that is intended to exclude surface contamination or undesirable ground water.

Between the clean sand deposits, through which water moves freely, and the non-water-bearing clays, there is a large miscellaneous group of materials composed of mixtures of coarse and fine material but predominantly clayey. Of such character are the poorly assorted materials of till or boulder clay that were laid down by glacial ice, many of the alluvial deposits formed under very changeable conditions, and most of the residual materials produced by the weathering of igneous and metamorphic rocks. Such materials will not generally yield much water, but in many sections where they lie near the surface they yield small supplies to dug wells. However, because the water supplies to the wells may be transmitted largely through small crevices, these materials do not provide the maximum protection against pollution.

When individual grains of a deposit of sand become cemented together and the deposit becomes more or less hardened, the formation is called a sandstone. As long as the interstices are not completely filled, sandstone has the same general properties as incoherent sand with respect to the movement of both water and contamination. If the interstices are completely filled, the sandstone becomes essentially impervious, and any water that occurs in it in sufficient quantity to be useful as a source of water supply is found in fissures, crevices, and joints. In addition to hard sandstone, other rocks that contain water largely in fissures, crevices, and joints are trap rock, and most of the metamorphic rocks, such as quartzite, slate, gneiss, and chist. Because the joints, fissures, and crevices provide little filtering action to water passing through them, contamination can be transmitted for considerable distances through these rocks, although not as readily as through creviced limestone, broken lava rock, or coarse, clean gravel. Unweathered extrusive lava rocks may yield water chiefly from large openings that permit very free circulation of water. These openings may be due to the broken condition of the rocks or to the expansion of steam or other gas when pressure was removed during the process of cooling. The largest openings may consist of caverns and tunnels formed during the process of congealing from a molten state.

Unweathered limestone may be porous and permeable but it is generally compact and nearly impermeable except along its joints. Weathered limestone, however, generally contains numerous crevices, cavities, and channels that have resulted from the solution of portions of the rock by water that penetrated pre-existing openings. Some of these openings have

attained enormous size, as in the large caverns that are so common in limestone regions. Limestones may yield very large quantities of water from such openings. Because the large openings in both lava and limestone afford almost no filtering action, contamination can be transmitted through them freely for great distances.

B. RATE AND DIRECTION OF MOVEMENT OF GROUND WATER

Ground water is generally moving from an area of surface intake to an area of natural discharge except as it is diverted toward wells that are pumped or flow by artesian pressure. This movement is the result of difference of head in the groundwater system and is in the direction of the slope of the water-table under watertable conditions or in the direction of the hydraulic gradient in an artesian system. The contour of the water table can be determined by measurements of the depth to water in a sufficient number of wells that are not affected by draw-down through pumping and by referring such measurements to sea level or other datum plane. In most parts of humid regions the water table is built up from time to time by water penetrating from the surface during periods of heavy rain or in the spring when the frost leaves the ground. Natural discharge of the ground water, however, occurs only in low places. In humid regions, therefore, the water table generally slopes in nearly the same direction as the land surface, except where conditions have been modified by drainage, pumping from wells, or other agencies.

The direction of the movement of the ground water is an important factor in connection with the transmission of contamination. It is well established that contamination moves in the same direction as the ground water, and hence, as a general rule, wells should be installed up the slope and not down the slope of the water table from possible sources of contamination.

The rate of movement of the ground water has an important relation to the transmission of contamination from its source to the wells. However, definite data on the transmission of contamination by ground water are very meager. Obviously the bacteriological control of experiments to determine the rate of transmission is extremely difficult. It is fairly well established, however, that the great body of ground water is generally free from dangerous pollution except near the water table in the proximity of polluting agencies and except in very open rocks, such as cavenous limestone, extrusive lava rock, or coarse, clean gravel, in which contamination may be carried long distances. Experiments by Stiles and his assistants fully support this conclusion. Recognition of these general facts will aid greatly in adopting a safe practice in ground-water developments. Fortunately, small water supplies, such as are furnished by individual farm or domestic wells, are drawn from relatively small areas and can generally be made safe by locating the well up the slope and as far as practicable from possible sources of pollution and by proper well construction. Wells that are heavily pumped, as for public waterworks, draw their supplies from greater distances, and therefore, in the nature of the case, greater precautions are required to assure safety.

The horizontal distance from any source of contamination should not be less than 50 feet, but this distance should be used only where ideal conditions indicate it to be sufficient; a greater distance should be required where local conditions demand it. If satisfactory sites are not available, adequate treatment of the water should be provided.

In connection with the investigation by C. W. Stiles and associates of the United States Public Health Service into methods of disposal of privy wastes in rural districts, extensive and rigorously controlled experiments have been made which bear upon the subject at issue and especially upon the movement of bacteria, of fecal origin, in the groundwater. These studies have involved the experimental pollution of the ground-water (namely, the water in the saturated zone, which supplies wells and springs), have been correlated with the rise and fall of the ground-water table, the flow of ground water, and the rainfall. Natural can material (human excreta from can type privies) was used as pollution material, Bacillus coli was taken as the bacterial test, and a dye (uranin) was utilized in tracing the movement of the water from the dosing trenches to the more than 400 experimental pipe wells which were arranged at intervals from the trenches and at various depths into groundwater.

The examination of thousands of water samples from the wells during a period of more than a year has resulted in very definite data which seem to express practically a natural law as applied to the movement of the bacteria in the field of fine sand in which the experiments were conducted. The results to date may be summarized as follows:

1. Pollution with fecal Bacillus coli has been definitely and progressively followed in the ground-water for distances of 3,6,10,15,25,35,45,50,55,60 and 65 feet from the trench in which the pollution was placed; uranin (a dye used in tracing movement of ground-water)

has been recovered from these same wells and has spread to other wells at 70,75,80,85,90, 95,100,110, and 115 feet from the pollution trench. The soil in question was a fine sand and an effective size of 0.13 mm.

2. The pollution traveled these distances within a period of 187 days, or about 27 weeks, and only in the direction of the flow of the ground-water; no convincing evidence was present that the pollution traveled against the flow of the ground-water or at right angles to it.

3. The pollution traveled only in a thin sheet at the surface of the zone of saturation; there was no evidence that it dispersed radially downward, and even heavy pollution was recovered at the top, water from lower levels (in near-by deeper wells) was negative both for uranin and for Bacillus coli.

4. As the ground-water level fell, owing to dry weather, the pollution tended to remain in the sand above the new (lower) ground-water level, namely, in the new capillary fringe.

5. There was no evidence which would justify a conclusion that either the bacteria or the uranin was carried or moved to any appreciable distance in the capillary fringe itself,and there was neither theoretical reason nor experimental evidence to justify a conclusion that either the bacteria or the uranin progressed in the dry, aerated intermediate belt (between the capillary fringe and the upper soil belt). All present evidence is to the effect that when the ground-water level falls the pollution remains practically stranded in the capillary fringe or in the intermediate belt according to the degree of fall of the ground-water.

6. A rainfall of 1 inch resulted in a rise of 5 to 6 inches in the ground-water table (in the particular experimental area in question); and if this rise was sufficient to re-establish the zone of saturation up at the level of the stranded pollution, the bacteria and the uranin were again picked up and carried along farther in the direction of the ground-water flow until dry weather again intervened to cause another fall of the ground-water level.

7. Thus the progressive (passive) movement and the stasis (stranding) of the pollution were intimately connected with, were dependent upon, and alternated with the rise and the fall of the ground-water level, and this latter factor was dependent upon the alternation of wet weather (rainfall) and dry weather (lack of rain at the intake area of the ground-water table).

8. In explaining these results, capillarity, filtration, and gravity seem to come up for special consideration.

9. In one experiment the pollution traveled only 45 feet from Setpember 1922 to May 1923, and remained stranded at this distance. Study of the formation of the ground revealed that under the belt of pollution there was an impervious or nearly impervious stratum of peat-like material, which gradually tilted upward distally from the pollution pit and formed a ground-water dam; the pollution traveled out on high ground-water to the dam, the ground-water level fell below the crest of the dam, and the pollution was stranded, pending a rise of the ground-water table sufficient to produce a ground-water cascade which will carry the pollution over the crest of the dam.

10. The ultimate distance to which pollution will be carried is dependent upon a number of complex and interlocking factors, namely, wet and dry weather, with resulting rise and fall of the ground-water; the length of each of these periods; the rate of the ground-water flow (depending upon the "head", which, in turn, is dependent upon the rainfall); and,obviously, also the factor of the viability of the organisms under conditions of moisture, pH, food supply, et cetera, ad finem.

11. In another series of experiments human feces were buried in pits, in a locality of high ground-water, and covered with sawdust. Of five samples taken three years and two months after burial all were both microscopically and magroscopically recognizable as feces, but the odor had become somewhat musty; three of these samples were positive and two were negative for Bacillus coli; ova of Ascaris lumbricoides were recognizable in all five samples, but all 57 ova found were dead.

12. The bearing of the foregoing results upon the intermittent pollution of wells, the location of water supplies, and the location of camps in peace or in war, will be evident to persons who are called upon for technical advice in these matters; the justification of the laws forbidding the use of abandoned wells for the disposal of excreta is self-evident; the possible effect of the custom (in some localities) of digging pits into ground-water (as advised by some) is obvious.

13. In protecting wells, special attention should be given not only to surface protection

as is now generally recognized but also to a new element, namely. the danger zone which exists from the higher water level to about a foot below the lowest water level. A leak in the pipe in this region is potentially very dangerous, and all wells unprotected in this danger zone are to be considered as potentially unsafe.

C. MODE OF OCCURRENCE

The protection of ground-water supplies from contamination is in a large measure dependent upon the mode of occurrence of the ground water. Under conditions where water is taken from just under the water table and not under pressure, surface waters or other liquid wastes are free to percolate downward through the interstices of the rocks and reach the water table or upper surface of the zone of saturation. The greatest measure of protection from pollution of ground-water supplies occurring under these conditions is afforded by having the well located as far as possible from all surface sources of contamination. Furthermore, considerable protection is secured by constructing and casing the well so that the supply is drawn from as far below the water table as possible.

Considerable protection to the supply is furnished by the presence of beds of impervious material between the surface and the water table. Obviously such material as, for example, a stratum of impervious clay, will interrupt the downward percolation of pollution and prevent it from reaching the main body of ground water supplying the well.

Ground water occuring under artesian conditions is confined under hydrostatic pressure by means of more or less impervious beds; and because of the pressure of the water, such supplies are the best protected as far as surface contamination in the vicinity of the well is concerned.

D. RATE OF PUMPING

In water-table wells, pumping creates a cone of depression in the water table in the vicinity of pumped wells, and water is drawn toward the well throughout the zone of influence. Hence, even though a source of supply is located up the slope of the water table with reference to a source of contamination, such supply may be adversely affected by reversing the normal direction of movement of the ground water. Zones of influence may vary from a few feet in diamter to several hundred feet or more, depending upon the rate of pumping and the character of the water bearing material. Furthermore, pumping, by increasing the slope of the water table, accelerates the rate of movement of the ground water, and hence contamination that might otherwise be rendered harmless by the filtering action occurring during normal movement of the ground water may be drawn into the well and issue with the pumped water. Under artesian conditions cones of depression are developed in the pressure surface, but protection is afforded by the confining bed.

E. FLOODING AND DRAINAGE

The top of every pump-room floor, pump platform, or cover of a ground-water supply should not be less than 2 feet above the highest known water level or the controlled high-water level of any lake, pond, stream, or any other body of surface water, the waters of which at the highest level would approach within 50 feet, measured horizontally, of such ground-water supply. The earth surface should be sloped to drain away from or divert surface water around the well or pump house, and be so graded as to prevent the accumulation and retention of surface water within a distance of 50 feet from the well. Filling should be protected from erosion by rip-rap where necessary.

F. TOILETS, FLOOR DRAINS, AND THE LIKE

Toilets, sewers, floor drains, soil pipes, main drains, or other pipes which are connected directly to a storm or sanitary sewer, or through which water or sewage from any source may back up, should not be located nearer than 50 feet, horizontally, to any well, spring, infiltration system, pumping apparatus, suction main, air pipe, air compressor, filter, or other feature of any ground-water supply. In special cases, where it is impossible or not practical to obtain a 50 foot distance, special construction to provide additional safeguards is necessary. In no case shall such fixtures or piping be nearer than 30 feet to a well. All such sewers, drains, and pipes, or parts thereof, which must be more than 30 feet and which are less than 40 feet, horizontally, from any such water supply feature, should be constructed of extra heavy cast-iron pipe with tested watertight leaded joints. In this zone, joints should be further protected against leakage by a substantial slipover sleeve extending at least 6 inches from each side of the joint. The annular space between the pipe and the sleeve shall be filled with asphalt or material such as sewer-joint compound, or closed with rubber gaskets. All such sewers as lie between 40 and 50 feet of the ground-water supply may be of extra heavy cast-iron pipe with tested watertight leaded

joints. Toilets, sewers, soil pipes, or drains should not be located on the first floor directly above the pump-room floor, or where leakage therefrom can reach any source of water supply or pump room.

Floor drains constructed of cast-iron pipe with leaded joints may be located as close as two feet to a ground-water supply, provided they do not connect to a storm or sanitary sewer, and provided they discharge only to the ground surface or to a gravel pocket which is well removed from contact with sewage or other waste. The cast-iron pipe should be carried to a point at least four feet outside the building walls and connected to other suitable pipe which discharges at least thirty feet from the ground-water supply.

G. PITS

Well heads, well casings, pumps, pumping machinery, valve boxes connected with a suction pipe, or exposed suction pipe should not be located in any pit, room, or space extending below ground level, or in any room or space above ground which is walled in or otherwise inclosed so that it does not have free drainage by gravity to the surface of the ground. Any pump room or such walled-in space above ground should be provided with a doorway and door at least six square feet in area, which opens outward and extends to the floor.

Pump rooms, in addition to having a floor drain and door that opens outward, should be provided with a relief panel set in the wall or door at floor level. This panel should be made of paper or other material which will give way under contact or pressure of water and permit the drainage of the floor onto the surface of the ground.

All that space below ground surface lying within a distance of ten feet of any well, spring, infiltration system, suction pipe, pump room, or like feature of any ground-water supply should be filled with compact earth.

SIMPLE TESTS TO DETERMINE SOURCES OF POLLUTION

Contamination of water is an index of disease carrying potential. Sources of pollution and possibly of infection may often be determined by simple tests. The tests consist in the addition of some chemical substance to the suspected source of pollution and then determining whether the chemical substance reappears in the water supply. For this purpose a large number of substances that may readily be recognized by taste, odor, or appearance may be used, such as coal oil, carbolic acid, fluorescein and common salt. The conclusion must not be drawn that because these soluble materials reappear in the water, micro-organisms and dangerous pollution would necessarily find their way through the soil for an equal distance. Soil has filtering powers and when free from fissures is capable of removing large amounts of bacteria and oxidizing much organic matter. These methods, however, are of service for indicating the possibility of danger under certain circumstances and are particularly useful in discovering sources of pollution near wells or in limestone formation.

MINIMUM DEPTHS OF GROUND-WATER SUPPLIES

Wells, infiltration systems, and springs should be constructed to a depth sufficient to insure that safe water can be obtained. The minimum depth at which safe water can be obtained will vary with different soil formations and surrounding conditions. In no case should water be drawn from a depth of less than 10 feet. Ground-water supplies should be protected against the entrance of surface water or shallow ground water and should exclude undesirable water strata which may be encountered.

When the water enters the inclosing structure of springs or infiltration systems at points less than 10 feet below ground surface, they may be protected by placing earth filling over the area involved (50 feet around) to provide the necessary depth of 10 feet of earth over the points of flow. If this is impracticable, adequate treatment should be provided.

TYPES OF WELLS: A well may be defined as a hole or excavation in the ground made deep enough to strike the water bearing strata in the soil. A shallow well extends to a depth above the first impervious stratum in the soil. A deep well obtains water from a stratum below the first impervious stratum in the soil. A dug well usually is a shallow well not more than 25 feet deep. A dug well is usually constructed by hand digging. A driven well is also usually a shallow well and is constructed by driving an iron pipe into the ground until it reaches the water bearing stratum. Bored wells are also usually shallow wells and are constructed by use of augers driven into the ground either by hand or under power. Drilled wells may be either shallow or deep wells and are constructed by power drills. Wells may also be classified as artesian or non-artesian. An artesian well is one that penetrates the first impervious layer in the soil and a non-artesian well does not. Artesian wells may or may not be flowing wells.

The filtering power of the soil is usually sufficient to protect the water drawn from a well, unless: (1) The soil is overburdened with organic matter (2) A cesspool, broken sewer, or other gross source of pollution is close by (3) Channels, fissures or crevices exist in the soil and waters reach the well without undergoing the process of biologic filtration.

All abandoned wells should be tightly sealed by approved methods or filled with clean earth or clay to prevent pollution of the ground-water.

Artesian water and deep well water furnish the safest and among the most satisfactory sources of supply. Some waters are usually clear and of high sanitary quality but sometimes contain a large amount of iron, manganese or other inorganic impurities which may render them unfit for domestic purposes. These inorganic compounds may be thrown out as insoluble compounds by oxidation upon coming into contact with air and may render the water yellowish or brownish. Deep well waters may contain an excess of lime and manganesium salts, common salt, hydrogen sulphide, carbon dioxide, and similar substances.

CONSTRUCTION OF WELLS: (5)

Dug wells are ordinarily more difficult to construct and keep safe and are sometimes more expensive than driven or drilled wells. They should be installed only when driven or drilled wells cannot be used because of the nature of the water-bearing formations. Any well which is to deliver safe water continously must be so constructed as to exclude the entrance of all foreign material through the top and all shallow ground water through the upper portion of the well. The upper 3 or 4 feet of ground contain bacteria and other contaminating material. As the water trickles through the ground it picks up bacterial contamination in the top few feet and these bacteria are then filtered out in the clean undisturbed soil in the next few feet. Experimental evidence has shown that water entering a well below a point 10 feet below the ground surface is usually free from bacterial contamination. But as a safety measure, the well lining should extend at least 10 feet below the water table at its lowest seasonal stage. Keeping out this contaminated shallow ground-water is relatively easy in a driven or drilled well, because of the seamless and absolutely watertight pipe or well casing which serves as the well wall. However, in the ordinary type of dug well, masonry walls of stone, brick or tile are commonly used, and it is impossible to make such a wall permanently watertight, even though cement mortar be used by expert workmen.

CONSTRUCTION OF ORDINARY TYPE DUG WELL:

Well Lining (See illustration No. 6). The only absolutely watertight well lining for a dug well is 6" of good concrete which must be poured in one operation. The wall must also be properly re-enforced and free from honeycombing. A 1:2:3 mix is recommended with just enough water to wet all the particles. Once the concrete wall is started it must be carried through to completion in order that no cracks or seams will be left in the wall. The concrete lining should always be outside of the regular lining. In an old well a trench can be excavated just behind the old lining using a post-hole digger with extensions on the handles. The old lining will act as an inside form and the earth as an outside form. The concrete should be placed carefully so as not to mix any earth with it. A small chute can be used to get the concrete to the bottom of the excavation. The concrete should be tamped thoroughly with a two by four after being placed.

If there is any possibility that sometime in the future an electric water pressure system will be installed, an 18" piece of good grade brass or copper pipe 1" in diameter should be placed through the well lining as the concrete is poured. This should be threaded and capped at each end. The pipe should be placed below the frost line. With such a pipe it will be a simple matter to connect up a water pressure system without disturbing the watertight well lining.

Vitrified tile pipe (sewer pipe) or concrete pipe - Vitrified tile or concrete pipe are not satisfactory as casing unless surrounded by at least 6 inches of portland cement concrete, as described in paragraph above. The customary joint in these pipes cannot be depended upon to be watertight.

Single brick walls - Single brick walls are not satisfactory unless surrounded by a 6 inch reinforced portland cement concrete wall, as described.

Metal casing - A durable watertight metal casing is satisfactory if installed in accordance with sanitary construction technique. The casing should be standard steel black pipe or its equal; riveted culvert pipe is not satisfactory.

THE WELL PLATFORM:

The well top or platform should be a watertight, reinforced portland-cement concrete slab of a minimum thickness of 4 inches, extending at least 2 feet from the well casing in all directions. The slab should rest on compact earth. The concrete should be sloped from the well casing to the edge of the slab. The surface of the slab at its outer edges should be 4 inches above the surrounding ground surface. The pedestal to which the pump base is to be fastened should be poured or cast with the slab not later than 30 minutes after that portion of the slab has been poured. The concrete should be tamped thoroughly around the well casing and the pipe sleeve. A properly constructed drilled well is shown in illustration 3.

The pipe sleeve creating the drop-pipe opening shall be of a diameter sufficient to admit the pump cylinder, which is larger than the drop pipe for which it is constructed. It shall be so placed in the concrete as to extend ultimately 1 inch, or more, if the particular pump base will permit, above the top of the pedestal on which the pump will rest. Details of this construction are shown in illustration 7.

If possible, a metal flange should be used to support the well pump. This flange should be either welded or bolted to the outer casing of the well. A gasket should be placed between the metal flange and the base of the well pump before they are bolted together.

Where it is impossible to provide a metal supporting flange, the well pump base may be bolted to the concrete cover slab of the well. A gasket should be placed between the base of the well pump and the concrete slab before the pump is bolted down.

Manhold openings in the cover slab of a dug well should be curbed to a height of not less than 6 inches above the top surface of the cover slab. This curb may be built into the manhold frame where a cast-iron frame is cast in the concrete slab, or the curb may be of concrete, provided it is poured with the slab or within 30 minutes after that portion of the slab is poured. The manhold cover must be watertight and should overlap the curbing and extend downward around it at least 2 inches. Provision should be made for locking the manhole cover. Approved types of manhole covers, and locks are shown in illustration 8.

BORED WELLS:

In some sections of the country a bored well is used quite extensively. A large diameter dug well is used when the ground water is not abundant and some storage space is necessary. If ground water is abundant and flows into the well rapidly there is no need for storage and a smaller diameter well can be used. If the water can be found close to the surface it may not be necessary to have a deep drilled well but a well can be bored to a depth of 30 to 60 feet with an auger. The hole is usually about 12 inches in diameter and is commonly lined with glazed tile, concrete pipe, or a wooden box. All of these linings permit shallow ground water to enter the well and thus cannot be approved by the health authorities. An existing well of this type can be reconstructed by considering it a small dug well. A concrete lining 6 inches thick should be poured behind the existing casing. The lining and the top platform are constructed similarly to that of the dug well. (See illustration No. 5).

A new bored well can be constructed a little differently and more economically by the following method: (Refer to illustration No. 5). The hole is dug and the ordinary lining (wood or tile) is brought up to a point 10½ feet below the earth surface. Then a section of 4 to 6 inch pipe 11 feet long is lowered into the hole. This pipe should have a flange 12 inches in diameter threaded to the lower end so that it will fill the space between the 4 inch casing and the sides of the hole. This pipe is placed so that it will extend 1½ inches above the top surface of the concrete platform. The space between the casing and the sides of the hole is then filled with clean earth from the flange, 10½ feet below the surface, up to the surface. This earth should be placed in thin layers and thoroughly tamped and compacted as the hole is filled.

The ground surface around the casing should be smoothed and the platform poured around the casing so that the casing will extend at least one inch above the top surface. Bolts should be placed in the concrete so that they will fit into the holes in the pump base. The pump base can then be bolted firmly to the platform using a gasket between the base and the platform to make a watertight joint.

DRIVEN WELLS (Illustration 1)

Driven wells are one of the safest sources of water provided the well is protected at the ground surface. Usually a driven well has a pitcher pump which is not approved since it

must be primed. The ordinary deep well pump with a cylinder can not be used with a 1 or 2 inch driven well pipe, since the cylinder will not enter the small two inch pipe. Therefore, it is necessary to make a larger casing in the top part of the well. The well casing is the outer metal pipe into which the suction pipe extends. The outer surface of the casing is in contact with surrounding earth. The small pipe 2" in diameter should be driven until the water supply is obtained. The pipe should then be pulled back and about 8 feet removed. An 8 foot section of 4" well casing is then threaded to the 2" pipe by using a reducer. Then the pipe is driven down to its original depth. The top eight feet will be the same as a drilled well and will permit the entrance of a pump cylinder. The platform should be of concrete and should be 5 feet square (or in diameter) with the casing in the center. The sandpoint is the screen at the lower end of the drive pipe which prevents particles from entering the well. This screen sometimes becomes clogged. The platform should be so placed that the casing will extend an inch above the surface into the pump base. The pump should be of an approved type.

DRILLED WELLS:

Drilled wells are usually four inches in diameter and the casing should be of seamless metal and should extend 1 inch above the surface of the platform. The concrete platform can be poured around the casing since this type of well is rarely disturbed once it is built. The pump should be of an approved typed and the waste pumpage should be removed from the vicinity of the well.

HAND PUMPS:

A trough should carry all waste water to a point at least 15 feet from the well. From that point a small ditch should carry the water away. The pump should be a force pump with a solid seamless base and should have a packing gland at the top around the rod. Pitcher pumps and split base pumps or any pumps with openings through the base are not approved due to the possibility of contamination.

1. Hand pumps should be of the force type with cylinders placed below or near the water level so that priming will not be necessary. Direct-lift, chain-lift, and bucket pumps are not satisfactory.
2. The pump base should be of the solid one-piece recessed type, cast integrally with or threaded to the pump column or stand. Two-piece (split) open-work and adjustable bases are not satisfactory.
3. The pump base should be of sufficient diameter and depth to permit at least a 6 inch wall casing or 6 inch pipe sleeve used in the top of a dug well to extend at least 1 inch above the pedestal on which the pump base will rest.
4. Provisions should be made for fastening the pump base rigidly to the pedestal and well top to prevent movement of the pump. This may be accomplished by securing the pump base by means of bolts imbedded in the concrete, or by the use of a flange or pump stand secured to the casing top. A pump brace should be used to provide stability to the pump setting. Suitable gaskets should be used between the pump base and the pedestal or the flange, as the case may be.
5. The pump head should be designed to exclude contamination by hands, dust, rain, birds, flies, and similar sources, from the water chamber of the pump head. Force pumps are reasonably protected against such contamination by the stuffing box which surrounds the pump rod. Ordinary lift pumps with a slotted pump-head top are open to contamination and should not be used.
6. The pump spout should be of the closed, downward-directed type. The open type commonly used on "pitcher pumps" should not be used. Suitable types of hand pumps and pump settings as described in this section are shown in illustrations 1, 2D, and 5.
7. Pumping equipment can be obtained which makes the use of pits or sub-ground-level pump rooms unnecessary. Standard parts can be purchased and assembled in such a way as to accomplish the same results.

With double tubular wells, i.e., wells which have a casing and a drop pipe, pump cylinders and "weep holes" in the drop pipe, or bleeders, are located inside the well casing so that pump drainage can run back into the well. With such an installation, a frost pit is not necessary. A method of providing an underground discharge without the use of a pit below ground surface is shown in illustrations 4A and 4B.

8. Hand-operated types of pumps which require priming should not be used.

POWER PUMPS:

For power pump installations it is a good idea to submit a sketch of the proposed layout to the Division of Public Health Engineering of the State Department of Health since every installation will be a little different from every other.

1. Pump-room floors. Every pump-room floor should be watertight, should be at least 6 inches above the ground surface at the outside edges, and should slope away from the pump, well casing, or suction pipe in all directions. Pump houses located on side-hill slopes should have at least 50 percent of the floor area above ground level. The door and relief panel should be located on that part of the floor above ground.

2. Pumps. The discharge tee, together with the valves, should be above the pumproom floor. Underground discharges, except for hand pumps or those equipped with a jack, are unsatisfactory and should not be used. Any pump placed immediately over the well casing or pipe sleeve should have a water-tight metal base to form a cover for the well. The base plate should be recessed on the under side to permit the casing or pipe sleeve to extend into it at least 1 inch above the level of the concrete foundation, thus forming an overlapping cover with edges projecting below the top of the casing or pipe sleeve. When it is necessary, a separate watertight cover of this type should be provided. Good drainage should be established away from the well and off the base plate so as to prevent the accumulation of waste water at this point. Rubber tubing is not satisfactory for wastewater connections around or over the base of the pump. If an air-relief vent is necessary it should be screened and protected against the possibility of contaminating material entering the vent. The open end of the vent should be at least 24 inches above the floor. A vertical vent covered by an overlapping hood may be used. Metal tubing should be used for vents, waste, and lubricating water, and waterlevel gages.
Illustration 9 shows proper installation of a vertical turbine pump for drilled well.
Illustration 10 shows properly constructed dug well and pump room.
Illustration 11 shows small power pump for a drilled well situated in an insulated pump house.

3. Water lubrication. Pump bearings situated in any well below the pump-room floor should be lubricated with water taken from within the well, from the reservoir or distribution system supplied with water from the original source of water supply, or from another supply which meets with the requirements of the State Department of Health.

4. Suction pipes.
All suction piping, such as that leading from detached wells or reservoirs, when laid underground should be at least 10 feet below the surface of the ground, or special protection should be provided. The surface contamination is generally retained in the upper zone of the earth, and filtration may be insufficient to prevent the contamination from reaching the suction pipe. All that part of any suction pipe within 10 feet of and below the surface of the ground should be surrounded by a watertight outer casing pipe. In the case of a suction pipe rising to a pump-house, the outer casing should extend at least 13 inches above the ground and 7 inches above a platform or floor surface. The annular opening between the protective casing pipe and the suction pipe should be filled in and properly covered at the top in a manner similar to that used for covering the top of a drilled well. Illustrations 12, 13, and 14 show satisfactory covers.

The important thing to consider is the method used in sealing the annular space at the top to prevent leakage. This space is between the drop-pipe (or suction pipe) and the well casing. The space can be closed by a reducer (See sketch "B" on illustration No.2). Bolted flanges with gaskets will work in some instances while others may have a packing gland. (See illustration No. 3). Oakum and lead make an easy and inexpensive seal. Sand and asphalt compounds or cement grout may be used. Whatever method is used should be approved by the Engineering Division of the State Department of Health before being installed.

Horizontal suction pipes which are located underground within 10 feet of the surface may be protected by placing sufficient earth filling on the surface to provide a total of 10 feet of covering over the piping. By placing the pumps directly over the well, sump, or reservoir, or locating the suction pipe above ground in a frost box, where necessary, the hazards of a suction pipe located less than 10 feet below ground level will be avoided.

5. Priming. Water for priming pumps on any water system should be taken directly from the reservoir or distribution system which is supplied with water from the original source of the water supply, or from another supply which meets the requirements of the State Board of Health. Priming devices should be so constructed that they will not expose the water to dust, drippings, or other sources of contamination.

6. Cooling Water. Water used for cooling parts of engines, air compressors, pumps, or other equipment should not be returned to any part of the water system.

7. Valve boxes. Every valve box on a buried suction pipe line should project at least 6

inches above the floor if in a building or room, and at least 12 inches above the ground surface if not enclosed in a building. The top of the box should be provided with a cover of the same overlapping type as hereinbefore prescribed for manholes. This arrangement is shown in illustration 15.

8. Airlift systems. Where water is pumped by means of an airlife system, the air compressors should be placed in a room as free as possible from dust, and at such an elevation that flooding will be made impossible. The compressed air from the compressor should be discharged into an air storage tank so designed as to extract from the compressed air any oil or oil mist which may have entered during its passage through the compressor. In order to minimize the possibilities of oil contamination, the use of oil traps, filters, and as little oil as will provide satisfactory operation of the compressor is recommended.

   The air intake of any airlife system or mechanical aerating apparatus should be at least 6 feet above the floor surface if indoors and 10 feet above the ground if out of doors. The air intake should be so constructed as to prevent the entrance of birds, insects, rain, snow, or other contaminating material and to minimize the entrance of dust.

   Air intakes for aerators or for pressure tanks should be located and protected as hereinbefore outlined. Locations which are dusty or poorly ventilated should be avoided. A suitable type of air inlet is shown in illustrations 16 and 17.

GROUND-WATER SUPPLIES, TREATED:

Ground-water is not only used for rural purposes, but in many instances is also used as public water supplies. In many areas where sufficient quantity or desirable quality of surface water is not available, ground water supplies are used very effectively. Treatment of underground waters may become necessary where safe sources are not available or when changes in sanitary conditions occur in existing supplies. It is recommended, however, that in order to minimize the hazards and the possibility of overloading the treatment plant, and in order that the treatment may be reserved as a factor of safety as far as possible, the principles and requirements set forth in the section for untreated underground waters be complied with as far as possible, even though treatment is employed. Treatment of underground waters should not be considered as substitute for proper location, construction, and operation, but rather as a safeguard and as a means of providing for the deficiencies that cannot otherwise be overcome.

Treatment should be employed when there is a possibility of contamination reaching the water underground and rendering it unsafe for domestic use. Treatment, however, should not be used permanently to overcome a defect of construction which can and should be corrected.

Where a treated underground supply is in use and an equally good untreated supply can be obtained, the treated supply should be considered as temporary, to be used only until the untreated supply can be made available. Treatment may then be used as an additional safeguard.

On a site where the earth formations permit the rapid movement of ground water, such as coarse gravel, fissured rock, solution channels, and similar formations, the ground water cannot be considered safe, and adequate treatment should be provided. Whenever necessary, ground water is treated in accordance with the principles and techniques of treatment of public water supplies.

DISINFECTION OF WELLS:

Wells recently constructed, or wells where repair work has been done, should be thoroughly disinfected before being put into use. The well should be first pumped to remove turbidity if possible, or to lower turbidity, so as to make treatment more effective. Disinfect by placing one-half pound per 100 feet of well casing, of chloride of lime containing 24 per cent available chlorine. If a stronger chloride of lime is selected, a smaller proportion may be used. The lime should be mixed with a small amount of water to a thin paste, sufficient water added to make about two gallons, and the entire mixture poured as near as possible to the bottom of the well by means of a pipe. The water level should then be raised and lowered several times to secure as complete distribution as possible through the water columns in the well. The well should be allowed to stand several hours, and should then be thoroughly pumped out. In gravel wall wells, the gravel should be chlorinated as it is placed in the well. A solution containing one-half pound of chloride of lime (24 per cent available chlorine) should be used to every cubic yard of gravel placed in the well.

SAMPLING:

It should be borne in mind that if wells are not properly constructed and are subject to contamination, the sterilization has only a temporary effect. Sterilization affects only the water in the well at the time of treatment, and improperly constructed wells may be contaminated a few minutes after treatment. In deep wells, the chlorine may not penetrate to the bottom of the well to effect complete sterilization. In order to insure a safe water supply, a sample should be collected for bacteriological examination. These examinations are made in the state bacteriological laboratories. Bottles for obtaining samples may be had upon request.

SPRINGS:

The protection of springs against contamination requires careful study of each location. It appears to be the popular idea that spring water has some magical quality which protects it from all possibility of pollution. The chances for contamination, however, are many. The most important of these is the possibility of the entrance of surface water. The movement of ground water is such that most springs are situated on a more or less gentle slope, quite frequently at the base of such a slope. Consequently, the chances of surface washings entering the basin of the spring is very great. The spring which is muddy after rains should be looked upon with suspicion, particularly so if it emerges from a limestone formation. Springs are also contaminated by hands and utensils when dipping the water from them. Wild and domestic animals may also foul them.

To prevent pollution by surface washings an earth embankment with a ditch on the upper side should be thrown around above the spring to deflect surface water during and after rains. (See illustration 18). The spring should be enclosed (walls and top) in a concrete box. The walls should be 6 inches thick. The top should be at least 6 inches thick reinforced with heavy wire netting or stock fencing. The depth to which the walls extend will depend upon the location and course of the spring. The walls should extend into the water bearing sand. The flow should leave the basin or concrete enclosure through a pipe which is screened at one end to prevent frogs or insects from entering. If large amounts of water are needed and the spring is situated on a higher level than the house, the water may be conducted by a pipe from the enclosed basin to a storage cistern at the house. This cistern should be water-tight and provided with an overflow pipe from which utensils can be filled and also with a pump which will enable the drawing out of the water in storage.

CISTERN SANITATION:

During periods of dry weather, dust which may be from the droppings of animals collects on the roof; further contamination may be deposited on the roof by bird droppings. When it rains, these accumulations are washed into the cistern. This is the most common cause of the contamination of cistern supplies used for drinking water. If the dust contains dried material blown from surface toilets, and it frequently does, the water may cause typhoid fever, dysentery and other diseases.

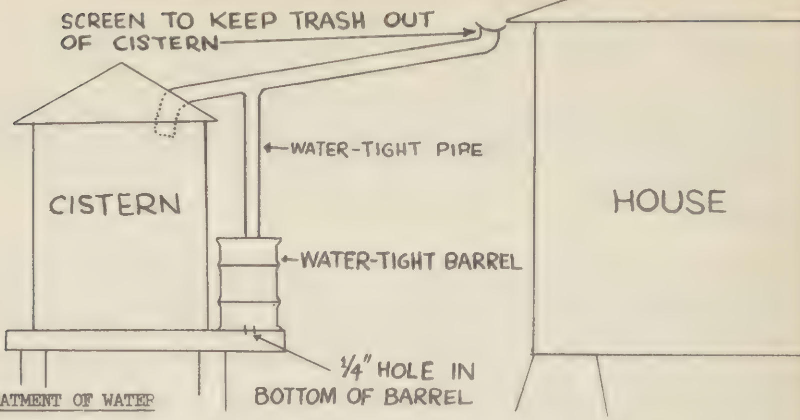
This contamination may be prevented by the use of a cut-off, a device by which the first washings from the roof may be allowed to flow to the ground and no water allowed to enter the cistern until the roof is washed clean.

The simplest form of this device is a Y in the pipe leading from the roof, with a flap valve. The usual position of this valve should turn the water to the ground so that if it rains during the night, or when no one is around, the water will not enter the cistern. A better method, since it is automatic, is to place a barrel or other container at the bottom of the pipe leading to the ground, with a water-tight connection between the pipe and the barrel. The barrel should have a small hole punched near the bottom to allow the water to flow out. When it rains, the water flows into the barrel faster than it flows out. When the barrel and pipe are filled, the water will flow into the cistern, but by this time the the roof has been washed. After the rain is over, the water leaks out of the barrel and the device is ready for the next rain.

Cisterns should be tightly covered and should be screened to prevent them from becoming breeding places for mosquitoes.

After construction or cleaning the cistern should be sterilized with a chlorinated lime solution the same as used in wells.

Diagram for Automatic Cut Off on Cistern



HOUSEHOLD TREATMENT OF WATER

1. Boiling. This process should continue for 20 minutes before water is considered sterilized.

2. Disinfection. (a) Two drops of iodine to 1 quart of water. Mix thoroughly and allow to stand 30 minutes. (b) Make stock solution of chlorinated lime containing 24% available chlorine by dissolving 1 teaspoonful in 1 pint of water. This is tightly stoppered and kept in dark colored glass bottle or in a dark place. One teaspoonful of this solution will disinfect 2 gallons of drinking water. It should be thoroughly mixed and allowed to stand for at least 30 minutes before drinking. If a stronger chloride of lime (HTH) is employed, use only one-half the quantity. (c) Halazone tablets are obtainable at drug stores in bottle containing 100 tablets. One tablet dissolved in a quart of water will sterilize contaminated water. If water is greatly polluted, 2 tablets to each quart should be used. Water should stand one hour after treatment before using.

3. Household Filters. The technical features of operating this apparatus should be understood by the responsible persons in the family before relying on its safety.

References:

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4. Wells--Dug, Drilled, and Driven -- Illinois State Department of Health

5. Ground-Water Supplies -- Public Health Reports, Supplement No 124

6. Rural Water Supply and Sewage Disposal Systems -- New York State Department of Health

7. Municipal and Rural Sanitation -- Ehlers and Steel.

Illustrations 4A, 4B, and 7 to 17 inclusive are taken from reference 5.

Bacteriology of Milk

SOURCES OF BACTERIA IN MILK.

Even when drawn with aseptic precautions, milk always contains a certain number of bacteria which are derived from the milk ducts of the cow's udder. Their numbers vary considerably from quarter to quarter of udders and from cow to cow. They are highest in the fore-milk and lowest in the strippings. The average plate count of aseptically drawn milk has been given by different workers as less than 10 per cubic centimeter to several thousand. Many of the lower counts have probably underestimated the true number owing to unsuitable technique in counting, while many of the higher counts have probably been made on milk derived from udders that were not strictly normal. Considering the extraordinary frequency of mastitis, (50% of the animals in a herd often showing disease of one or more quarters), it is very difficult to arrive at any definite conclusion on the probable numbers of bacteria in milk coming from healthy udders. If the udder is diseased, streptococci, Br. abortus, tubercle bacilli, and other organisms may be excreted in the milk in large numbers--sometimes running into several thousands per c.c.

When aseptic precautions are not employed, the milk is liable to be contaminated with bacteria from the outside of the udder, the interior of milk vessels and utensils, and dust in the atmosphere of the milking shed. Of these various sources, by far the most important is unsterilized milking equipment. The total number of organisms gaining access from the air and from dust is almost negligible compared with that derived from the surfaces of unsterilized pails, coolers, cans, strainers, and bottle fillers. Unless these utensils are actually sterilized, their surfaces become coated with bacteria of various types which may contribute enormous numbers of microorganisms to the milk.

An additional source of contamination is the human personnel. If wet hand milking is practiced, considerable numbers of organisms are liable to get washed into the milk from the milker's hands, as well of course as from the exterior of the udder and teats, unless these are thoroughly cleansed. Though numerically few, the organisms reaching the milk in this way may be of considerable public health importance, particularly if the milker happens to be an intestinal carrier of typhoid, paratyphoid, dysentery, or food poisoning bacteria. The milker constitutes a further source of danger if he is carrying haemolytic streptococci or diphtheria bacilli in his throat or nose, since these organisms may gain access to the milk by way of the cough spray.

Apart from initial contamination of the milk, imperfect cooling is often responsible for the presence of large numbers of bacteria in any given sample. However carefully milk is produced, sooner or later, provided it is kept at a suitable temperature, it will go sour or putrid as the result of bacterial multiplication. If it is to remain sweet for more than a few hours, all milk should be cooled immediately after production to a temperature of 10°C (50°F) or below.

It may be noted that the keeping quality of the milk is determined partly by the degree of initial contamination and partly by the temperature at which it is kept. Milk produced under really clean conditions has a considerable bacteriostatic (prevents bacterial growth) power, and shows little bacterial multiplication for several hours, even when incubated at a favorable temperature. On the other hand, the bacteriostatic effect of milk produced under dirty conditions is very slight, and bacterial multiplication is rapid. For this reason, it is much easier to distinguish between a milk produced under sanitary and one produced under insanitary conditions if the examination is delayed till the milks have stood at a temperature of 60° F or so for 12-18 hours. After this time a milk produced under clean conditions will still have a low bacterial count, while a milk produced under dirty conditions will contain a large bacterial population.

The production of clean milk is largely a matter of technique, not of structural equipment or refinement. Provided all utensils are sterilized and the surface of the udder and the milker's hands are cleansed, it is possible to produce milk with a very low bacterial content even under unfavorable conditions. It is, however, not easy to maintain a satisfactory technique day in and day out unless suitable conditions and applicances are provided for the workers.

TYPES OF BACTERIA IN MILK.

The bacteria present in milk from healthy cows may be classified into the following groups:
1. Acid-forming Bacteria. These organisms ferment the lactose in the milk with the production of acid, mainly lactic acid, which combines with the protein compound (calcium

caseinogenate) liberating the free protein casein; this being insoluble in water, is precipitated in the form of a smooth, gelatinous curd. Lactic streptococci constitute some of the most important members of this group. Certain staphylococci, which are not infrequently found in the udder, are also active members of this group. Also included are the lactobacilli.

2. Gas-forming Bacteria. These organisms ferment lactose with the production of both acid and gas. They produce a smooth gelatinous curd which is often riddled with gas bubbles. The acid produced is largely acetic, which imparts an unpleasant flavor to the milk. Coliform bacilli (those whose habitat is in the intestinal tract, respiratory tract, soil, grain and grass, and which are gram-negative, non-spore forming bacilli, ferment lactose, produce gas, and grow aerobically on standard solid media) are among the commonest representatives of this group.

3. Protsolytic (Protein breaking) Bacteria. These organisms secrete one or the other, or both of two ferments--rennet and casease. Rennent acts in two stages; in the first stage it converts the protein compound, calcium caseinogenate, into a soluble form of casein; in the second stage this protein (casein) is converted into an insoluble form and is precipitated out. The resulting gelatinous clot gradually contracts and squeezes out a more or less clean fluid which is known as whey; the whey contains the sugar, salts, and other proteins--lactalbumin and lactoglobulin in the milk. Casease is a proteolytic enzyme, which digests the proteins present in the milk, breaking them down to more elementary forms (proteoses, peptones, and amino acids).

When the rennet predominates, a firm white curd is produced, which is slowly digested by the casease. When the casease is in excess, either no coagulation at all may occur, or a soft flocculent clot is formed which is rapidly broken down.

Many organisms fall under this heading: (a) Spore-bearing aerobes, such as B. subtilis and B. mesentericus; (b) Proteus vulgaris; and (c) staphylococci and micrococci. Some of the organisms in this group also ferment lactose so that the milk is rendered acid besides being clotted and digested.

4. Alkali-forming Bacteria. These organisms render the milk alkaline, presumably by acting on the proteins. Some of them also secrete lipase (enzyme which aids in breaking down of fat) and the combined effect (alkali, fat, and lipase) is to saponify (make into soap), the fat and convert the milk into a yellow translucent whey-like fluid. This action is not often seen, since the members of this group of bacteria are overgrown by members of other groups, which produce acid, coagulation, and peptonization (breaking down of proteins to peptones). Organisms belonging to this group comprise Bact. alkaligenes, and some of the aerobic spore-bearers.

5. Inert Bacteria. Many bacteria produce no visible change in milk and are hence called inert. Some of the udder cocci are included in this group. Members of the Achromabacter (produce no pigment) group, most of which are probably derived from water are also relatively inert. It may be noted that most of the pathogenic organisms which may be present in milk belong to this group.

6. The pasteurization of milk and the development of finer techniques for approximating the quantity of bacteria (by plate count) in milk has led to a classification of several types of bacteria according to their temperature reactions.

(a) Thermophiles. These are a group which were found to grow and reproduce in relatively high temperatures (around 60°C), whereas their growth and reproduction are suppressed as the temperature becomes lower. Thus, at normal body temperature, or at average weather temperatures they survive but do not readily reproduce. Because of this characteristic it has been found that some milk may show a higher bacterial count after pasteurization than before. Since such bacteria may enter milk through insanitary handling, it becomes necessary for milk produced for pasteurization to be handled in a most sanitary manner, even though these thermophiles are not pathogenic. They may be numerous enough in pasteurized milk to decrease its keeping quality. These bacteria may also accumulate in the niches of a pasteurization unit and if the unit is not regularly cleaned and sterilized the pasteurized milk may regularly show higher bacterial counts than the raw milk or may show counts too high to be considered grade A inspite of having been pasteurized.

(b) Thermodurics. Recently the short-time-high-temperature method of pasteurization (i.e., holding milk at about 71°C for 15 seconds) became very popular because it prevented the growth and reproduction of thermophiles and at the same time had the same effect as the long-time pasteurization process. But soon it was found that a

certain type of bacteria which grow and reproduce at around normal body temperature may survive the short-time-high-temperature method of pasteurization and may even survive if held for over 30 minutes at high temperature although they do not reproduce at such high temperatures. These bacteria are called thermodurics. Lately new techniques in making bacterial counts (by lowering the incubation temperature to 32°C. and enriching the media) has revealed that these thermodurics which did not grow so well under the old methods, grow and develop very well by the new technique. Thus, the bacterial count by the new method shows a much greater bacterial contamination of milk than by the old method. This has created a number of complications. First of all, previously adequate milk may show up as inadequate due to the increased count, and the dairies are put under a greater strain to keep within the upper limit of grade A range for bacteria. Secondly, it becomes apparent that the question must be settled as to whether the present bacterial ranges for grade A milk may not be too high and therefore need revision. These problems must soon be settled.

(c). Psychrophiles are bacteria which grow and reproduce best at lower temperature than body. Some of this group will grow at temperatures close to freezing.

PATHOGENIC BACTERIA IN MILK.

Apart from the organisms that we have described as being normally present in milk, there are others which sometimes are found in pathological conditions of the cow's udder, or which gain access to the milk from an infected water supply or from some person handling the milk.

Tubercle Bacilli. The presence of these organisms in milk depends on the frequency of bovine tuberculosis. The amount of tuberculosis among cattle in Europe is much greater than in the United States.

In Great Britian 30% of cattle show positive tuberculin reaction
In Germany 25% of cattle show positive tuberculin reaction
In Holland 40% of cattle show positive tuberculin reaction
In the U.S. (1910) 9% of cattle showed positive tuberculin reaction
In the U.S. (1918) 5% of cattle showed positive tuberculin reaction
In the U.S. (1936) 0.5% of cattle showed positive tuberculin reaction

Many cows which apparently look normal excrete tubercle bacilli in milk. Though definite disease of the udder cannot always be demonstrated clinically in these cows, they generally show tuberculosis mastitis on microscopic examination. The more milk is pooled, the more one can expect to find tubercle bacilli in market samples of raw milk. Butter may keep living tubercle bacilli over a period of many months. This bacillus is eliminated a good deal in the feces and may live for three to five months in the pastures.

Brucellus abortus. This organism is responsible for contagious abortion of cattle which is even more prevalent than tuberculosis. The udder is frequently infected even in animals that have not aborted, though no lesions can be detected by clinical examination. The bacilli are excreted regularly or intermittently in the milk. Their numbers are usually greatest at the beginning of lactation but in the later stages they may diminish greatly. The udder may remain infected for years. A high percentage of raw milk offered for human consumption appear to contain this organism.

Streptococci. Mastitis streptococci are of various types. The most important being Strept. agalactiae. They are excreted in variable numbers in milk of cows suffering from mastitis. This disease is extremely common, and affects not only the poorer herds, but even herds producing high-grade milk. The majority of streptococci causing mastitis in cows are probably not pathogenic for man, but occasionally a strain of the human type invades the udder, and may be responsible for outbreaks of scarlet fever or septic sore throat in persons consuming the milk. The milk may also be contaminated directly with those organisms from persons who are either suffering from streptococcal throat lesions, or who are carrying these organisms in their throats and nose.

Staphylococcus aureus. This organism is not an infrequent cause of mastitis. It is sometimes found in the healthy udder, but in cows suffering from acute mastitis it may be present in large numbers in the milk. Its public health importance lies in the fact that under favorable conditions, it may multiply in the milk and give rise to a toxin (poison) capable of producing gastro-enteritis (inflamation of stomach and intestines) in humans.

Corynebacterium diphtheriae. This organisms occasionally finds its way into the milk from the throat and nose of a human carrier or case of diphtheria. Very occasionally it becomes implanted on ulcers of the cow's teats. Such an occurrence is peculiarly dangerous, since the milk is in this way uniformly infected.

Typhoid, para-typhoid, food-poisoning, and dysentery bacilli. These important pathogenic organisms, which may occasionally contaminate the milk, are usually derived from human or other extraneous sources. Of 115 typhoid epidemics in U.S. 1930-35 caused by milk, 94.5% were due to raw milk.

QUALITY IN MILK.

Quality is a composite, not a single attribute of milk. There are, for example (1) The nutritive quality, (2) The Cleanliness, ( ) The keeping quality (4) The pasteurizability, and (5) The safety of milk, to mention only five of its most important attributes. Leaving aside the nutritive quality, which can be determined only by chemical analysis and animal feeding experiments, we may consider for the moment what we mean by the other four properties.

By cleanliness is generally understood the freedom of the milk from extraneous matter, from blood, and from an undue number of leucocytis (white blood cells) and bacteria. It is an unsatisfactory term, but by general usage it has come to bear this meaning.

The keeping quality of the milk refers, of course, to the length of time it will remain sweet, and free from odors and tastes that render it unpalatable.

The pasteurizability of the milk is a term devised to indicate the suitability of the milk for heat treatment. It is, of course, a mistaken idea that any milk can be pasteurized. A milk that is too acid will clot when the temperature is raised, and the resultant product will have to be discarded. Again, some milks contain large numbers of heat-resistant bacteria, which are not destroyed by pasteurization, and which therefore prevent the pasteurized product from conforming to the legal standards.

The safety of milk is a term denoting its freedom from bacteria capable of giving rise to disease in man or animals. It is by some writers confused with cleanliness, but there is no necessary or constant relationship between these two properties. Dirty milk, if free from pathogenic bacteria, may be quite safe, while very clean milks are not unfrequently dangerous.

For human consumption it is desirable that milk be both clean and safe. Clean milk is more aesthetically desirable, it has a better flavor, and it keeps longer. Moreover, it is not likely to contain any of those toxic substances resulting from undue bacterial growth, which have an irritating effect on the gastro-intestinal tract -- particularly of infants. The fewer organisms there are in milk, and the more their growth and reproduction is checked, the less liable is the milk to give rise to digestive disturbance.

As regards safety, it will be clear that no raw milk can ever be regarded as completely safe for human consumption. The frequency of disease in cattle, the risk of contamination from human and other sources, and the suitability of the milk itself as a medium for bacterial multiplication, combine to render the consumption of raw milk potentially dangerous. The only satisfactory way of eliminating this danger is by pasteurization or some form of heat treatment.

BACTERIOLOGICAL GRADING OF MILK.

From a public health point of view it is usual to grade milk bacteriologically partly according to cleanliness and partly according to safety. We will consider briefly the various methods available for these purposes.

Sampling. Since the answer given by any test is determined so largely (a) by multiple factors involved in the production and subsequent handling of the milk, (b) by the care with which the milk is sampled, and (c) by the time-temperature conditions under which the sample is taken and kept prior to analysis, it follows that it is unwise to pay too much attention to the results of any single examination. The most satisfactory procedure is to make frequent and regular examinations of the milk of any given producer throughout the year, and insist that a given proportion of the samples should come up to a given standard. In this way some allowance will be made for factors over which the producer is unable to exercise complete control, while at the same time insuring that the conditions of production as a whole are kept at a reasonable high level.

Every endeavor should be made in the sampling of the milk to obtain a homogeneous distribution of organisms and fat. If the intention is to test the cleanliness of production, it is desirable to expose the sample after collection to an agreed temperature for a given length of time, in order that the latent contamination in milk produced under bad conditions may have time to develop. When testing milk delivered to the consumer, on the other hand, it is desirable to ice the sample at once, so as to obtain information on the degree of

bacterial contamination at the time of the delivery by the distributor.

The Sediment Test. The amount of extraneous matter in the milk is determined either by filtration through a cotton pad or by centrifugation. A simple sediment test of this sort is of value in controlling the gross dirt in milk and in education of the unhygienic farmer. Since, however, filtration through muslin gauze on the farm will remove dirt of this type, the absence of an obvious sediment must not be taken to mean that the conditions of production were satisfactory. Most of the bacteria in milk come not so much from gross dirt, but from unsterilized utensils. Indeed, actual manure can be added to the milk without producing a marked increase in the bacterial content; for this reason a sediment test is useful for the detection of gross particulate matter, the presence of which is not likely to be detected by purely bacteriological tests.

The Cellular Content. Milk from normal udders contain, as a rule, less than 100,000 cells per c.c. But the perfectly normal udder is almost a curiosity because it is so rare, and therefore for practical purposes, a considerable margin on this figure must be allowed. Some workers claim that the range of cell counts of milk from the average apparently normal udder is from 200,000 to 1,000,000 per c.c. An abnormally high cell count maybe due to (1) retention of the milk in the udder causing acute and chronic inflammation; (2) various types of inflammatory diseases; (3) period approaching the end of lactation; (4) period approaching calving time (5) during periods of excitement. Usually we consider that milk containing more than 500,000 cells per c.c. indicates an abnormal or pathological condition in the udder. A mere count of the cells present affords little information about the quality of the milk, and it would be unwise to condemn a milk solely on account of an increased cell content. If long-chained streptococci are found in addition, the probability is that the cow is suffering from mastitis. Much more information can be obtained by a differential count of the cells (estimating the percentage of various types of cells present), but the real value of this method lies in the help it gives to the veterinarian who is engaged in a study of the individual cow.

The Breed Smear Method. The general technique of this method is to spread 0.01 c.c. of milk over 1 square centimeter of surface on a glass slide, dissolve out the fat with xylol and then stain the slide with methylene blue. Under the microscope the number of individual bacteria are counted and the number present per c.c. is calculated. The cells may also be counted by this method. This method does not distinguish between live and dead bacteria.

Whereas the American bacteriologist believesthat the Breed Count is a satisfactory method for detecting the quantitative character of bacteria in the milk as well as the qualitiative aspects, the British school believes that the Breed method has its place only as a qualitative indicator, i.e. in determining the quality by the type of flora found -- streptococci indicating mastitis and coliform bacteria indicating lack of cleanliness in production of milk.

The advantages of the microscopic method over the Plate Count method are:

1. Requires less apparatus
2. It is a simpler technique
3. It is less expensive
4. Results on a given sample can be reported within a few minutes
5. A cell count can be made by the same techniques,also the presence or absence of streptococci or other bacteria and contaminants important in estimating the sanitary quality of the milk
6. Give better idea of the actual number of microorganism present, although it does not distinguish between the individual and the colony
7. It gives a permanent record of the evidence
8. If the technique is carried out "on the spot", icing the milk can be dispensed with.

The Breed Count gives a consistently higher number than Plate Count. The usual relation is 4 to 1, i.e. the Breed Count is on an average of 4 times greater than Plate Count.

The Plate Count. The technique of the Plate Count method roughly consists of the following:

1. Three dilutions of the milk sample are made - 1 to 10, 1 to 100, and 1 to 1,000.
2. The original milk sample and each dilution bottle is rapidly shaken 25 times before making dilutions
3. One cubic centimeter of each dilution of milk is transferred to properly labelled Petri plates
4. Warm melted nutrient agar is then poured in each Petri plate and the milk and agar thoroughly mixed by gentle rotary motion
5. The plates are inverted and placed in an incubator at 37°C. for 48 hours. If thermophilic bacteria are suspected prepare additional plates and incubate at 45°C. for 24 hours. If psychrophilic bacteria are suspected, incubate at 25°C. for four days.

6. After incubation, those plates containing between 30 and 300 colonies are selected for counting. No plate containing less than 20 colonies shall be counted, unless it happens that there are no other plates. If the number of colonies on the plates to be counted is in excess of 300 per plate, a part of the plate may be counted and the total number estimated but such plates are overcrowded and the counts are less than they should be.
7. The total number of colonies on the countable plate, multiplied by the dilution is reported as the standard plate count, which means "an estimated count of colonies per c.c. as obtained by standard methods."

The plate count is one of the most widely used methods for the bacteriological grading of milk according to cleanliness. It is, however, exposed to criticism on many grounds. Ostensibly the plate count measures the number of bacteria in the milk, but in fact it does not. The bacteria in raw milk are of many different kinds and come from varied sources. Often a large proportion are dead, while those that are alive differ in their nutritional, respiratory, and temperature requirements, so that no one medium incubated for a given length of time at a given temperature under aerobic conditions can possibly afford a true estimate even of the living organisms present. More important still, however, is the fact that many of the bacteria are distributed, not individually but in chains and groups of varying sizes. The colonies developing on plates are derived therefore, not solely from individual organisms, but also from aggregates containing varying numbers of bacteria. In consequence, the plate count merely registers the number of bacterial units capable of multiplying under the particular conditions selected. Since the average number of bacteria per clump is variable from one milk to another, and not constant from time to time even in milk of the same origin, it follows that the figures yielded by the plate count are arbitrary, are not strictly comparable, and have no absolute significance.

When it is further pointed out that these clumps of bacteria may disintegrate to a variable and quite uncontrollable extent during the process of dilution, leading in extreme instances to errors of 1,000 percent, and that many of the individual steps in the technique of the count are very difficult to standaridize, and even when standardized as nearly as possible are attended by a large experimental error it will be realized that the figures yielded by the plate count are not merely arbitrary, but are also only approximate.

Even were it possible to standardize the technique of the plate count, it would still be necessary to allow a margin of 50 to 90% on the result of anyone milk, depending on the number of plates used for each dilution. Even this estimate would often fall short of the real variation met with in practice. However accurate the plate count may be for the enumeration of bacteria in pure broth cultures, it is plainly unsuitable for this purpose when applied to milk. Because the results are expressed quantitatively in figures extending over a wide range, they afford a fictitious appearance of accuracy which leads, not only in laymen, but even in public health officials, to a wholly unjustifiable feeling of confidence in their value. It is not denied that the plate count can be used as a rough yardstick for the grading of milk, but it is denied that it can be used as a millimeter rule.

The unaccuracies of the plate count have been attributed to many factors, but lately it has been shown that a variation of 1°C in the incubating temperature at 37°C may cause samples of milk to vary from 10 to 90% of the maximum two days' count, whereas a variation of 1°C in incubating temperature of 32°C causes on an average only a 4% variation in count. It is evident from these facts that many of the present unsatisfactory types of incubators which must be discarded if present standards are enforced would be satisfactory for milk control laboratories if the present 37° C temperature were changed to 32°C. In other words, there are a number of types of incubators which are satisfactory for use in milk testing at 32°C while at 37°C even the best incubators cause very real and serious errors in counts.

VARIABLES AFFECTING PLATE COUNT

1. Stage at which culture is obtained - from cow, from bottle, from pasteurizer,etc.
2. Temperature at which milk is kept till count is made
3. Sampling technique
4. Temperature of incubation of plates
5. Errors due to clumping of bacteria
6. Variability of count due to other reasons known or unknown.

The advantages of the plate count method over the microscopic are as follows:

1. It shows the character of the growing bacterial colonies
2. It shows only the living organisms
3. Pure cultures can be isolated from the plates
4. Gelatin shows the "liquifier" bacteria and if litmus is used the acid producer bacteria are indicated

5. On low count milk, the Breed Method is entirely inaccurate for a quantitative estimate of bacteria. The plate gives fair approximations of quantity.

Reporting Bacterial Plate Counts. The number of routine samples which must be examined in many cities makes the use of more than two dilutions per sample impracticable. For this reason it has become general practice for laboratories in cities enforcing this ordinance to make only two dilutions. In all except known high-count milk the dilutions used are 1-100 and 1-1,000; on the latter 1-1,000 and 1-10,000. The following special rules for reporting counts are now being used:

1. When the higher plate count is more than twice the lower, record the lower count.

2. When the higher plate count is not more than twice the lower, apply the Standard Methods rules for counting, which may be summarized as follows: (a) If there are plates with 30 to 300 colonies, use all of them and no others; (b) otherwise us e that nearest 300.

3. In case one plate cannot be counted because of a spreader covering more than half the plate, the result is to be reported as unsatisfactory unless the count of the other plate is within the grade then held by the supply in question.

4. Report bacterial plate counts to the nearest 1,000, unless the count exceeds 100,000, in which case report to the nearest 10,000, or unless the count exceeds 1,000,000; in which case report to the nearest 100,000.

5. Plates showing no growth shall be reported as unsatisfactory.

A good method by which milk control officials may judge laboratory technique and the correctness of reporting is to have the laboratory enter its results upon the following form of milk analysis journal.

MILK-SAMPLE RECORD (4)

Sample No.	Fat	Sp. G	S.N.F.	Adulterants	1-100 Count	1-1,000 Count	Count Ratio (1)	Recorded Count (2)	Rules for Reporting
	Percent		Percent	Percent					
2834	4.1	1.031	8.57	-	14,800	15,000	1.01	15,000	2A,4
2835	3.6	1.032	8.72	-	210,000	234,000	1.11	230,000	2A,4
2836	3.7	1.031	8.49	-	8,600	32,000	3.72	9,000	1,4
2837	4.2	1.030	8.34	-	(3)	190,000	-	(4)	3(grade A)
2838	4.1	1.031	8.57	-	29,300	41,000	1.40	35,000	2A,4
2839	2.3	1.025	6.71	9	-	-	-	-	water

(1) Count Ratio is the ratio of the greater to the lesser plate count
(2) Corrected
(3) Spreader
(4) Unsatisfactory

The state representatives should determine the following data each grading period as a part of the state records:

1. Average ratio of such samples for which both colony counts are between 30 and 300. This should not be over 2.0.

2. Percent unsatisfactory counts (spreaders). This should not be over 2 percent.

3. Percent incorrectly recorded counts. This should be practically 0.

These three figures are measures with which to judge the work of the laboratory.

All counts should be recorded on the milk ledger (Treasury Department Forms 8976-B and 8976-C) as soon as reported by the laboratory.

Averaging Bacterial Counts in Determining Grades. In grading milk supplies the average of the last four consecutive counts or reductase hours is used because less than this number has been found by experience not to give a dependable picture of the bacteriological condition of a milk supply. The averaging of bacterial counts in the determination of grades

under this ordinance is done by the logarithmic instead of the arithmetic method. This is because the arithmetic method is sometimes unfair to the dairyman. Suppose, for example, the laboratory reports the last four consecutive counts to be 10,000, 10,000, 10,000 and 1,000,000. The one unusually high count may have been the result of accident and is not fair cause for degrading, yet if an arithmetic average is used the milk supply will be placed in grade B, whereas its most usual quality is grade A.

For this reason the logarithmic average is specified in connection with the enforcement of this ordinance. By its use high counts are "snubbed", so to speak, unless all counts are high, in which case the snubbing effect tends to disappear and the logarithmic average approaches the arithmetic average. For example, the same counts previously listed would yield a logarithmic average of 32,000, thus keeping the milk supply in grade A, where it obviously belongs.

How to Find the Average Bacterial Count by Logarithms - The logarithms of all bacterial counts from 1,000 to 300,000,000 are given directly in the following table. The logarithms should be entered opposite the counts in the milk control ledger. To find the average bacterial count find the average of the logarithms and then find the bacterial count in the table which is opposite the average logarithm.

Following is an example: (4)

Counts	Logarithms
35,000	4.54
11,000	4.04
9,000	3.95
95,000	4.98
	17.51

17.51 ÷ 4 - 4.38 average logarithm.

4.38 in the table is opposite 24,000, which is therefore the average bacterial count.

If it is found that the average logarithm occurs opposite more than one bacterial count in the table, take the lowest bacterial count as the average. (See Table - Page 109)

The Coliform Test. Like the Plate Count, this method has been extensively used in the past for grading of milk without any real appreciation of the fundamental assumptives on which it rests. The determination of coliform bacteria depends upon (1) The ability of the media used to differentiate this group from other types of bacteria, (2) The variation in the types of coliform bacteria from one area to another, (3) The variation of the sources of contamination (soil, feces, etc.) from one area to another, (4) The ability of the coliform group to grow in the material to be examined. (In water it does not seem to grow, and in milk it grows rapidly).

The coliform test does not indicate from what source milk has been contaminated, it merely indicates that contamination has taken place from human, soil or vegetation source or sources. In some areas, the coliform bacteria may be composed of 50% human or cow sources or any percent above or below this rate. If true B. coli are found in milk they may come directly from cow-dung, manure, or human feces, or indirectly from unsterilized milk utensils in which bacterial multiplication has occurred. But the test could tell us nothing as to which source might be responsible. Unlike water, milk affords an admirable medium for the growth of coliform bacilli. If it is kept at a temperature of 50°F. or over, a great increase in their numbers may take place, a rise of several thousand-fold often occurring at 60°F. within 24 hours. Unless, therefore, the milk has been kept at 40° F. or less, an estimation of the coliform bacilli affords only a very imperfect, and often entirely misleading index of the extent of the original contamination. With a milk produced and kept under ordinary conditions, it is impossible to tell how many of the coliform bacilli gained access at the time of production, and how many are due to the multiplication of those originally present.

Factors which must be considered when the significance of coliform organisms in milk or cream is to be judged.

1. Whether milk is raw, pasteurized or reconstituted
2. Whether infection is present in udder
3. Whether sanitary condition of dairy is satisfactory
4. Whether a human carrier of typhoid is somewhere in the system of production
5. What is the source of materials and methods for making reconstituted milk
6. How long it is since the milk has been produced
7. Whether the milk had been properly iced
8. How the various phases of handling milk had been executed
9. Breed qualitative test and other qualitative tests should be considered for further evidence.

TABLE TO BE USED IN COMPUTING LOGARITHMIC AVERAGES OF BACTERIAL PLATE COUNTS (4)

1,000 - 3.00	61,000 - 4.79	310,000 - 5.49	910,000 - 5.96	6,100,000 - 6.79
2,000 - 3.30	62,000 - 4.79	320,000 - 5.51	920,000 - 5.96	6,200,000 - 6.79
3,000 - 3.46	63,000 - 4.80	330,000 - 5.52	930,000 - 5.97	6,300,000 - 6.80
4,000 - 3.60	64,000 - 4.81	340,000 - 5.53	940,000 - 5.97	6,400,000 - 6.81
5,000 - 3.70	65,000 - 4.81	350,000 - 5.54	950,000 - 5.98	6,500,000 - 6.81
6,000 - 3.78	66,000 - 4.82	360,000 - 5.56	960,000 - 5.98	6,600,000 - 6.82
7,000 - 3.85	67,000 - 4.83	370,000 - 5.57	970,000 - 5.99	6,700,000 - 6.83
8,000 - 3.90	68,000 - 4.83	380,000 - 5.58	980,000 - 5.99	6,800,000 - 6.83
9,000 - 3.95	69,000 - 4.84	390,000 - 5.59	990,000 - 5.99	6,900,000 - 6.84
10,000 - 4.00	70,000 - 4.85	400,000 - 5.60	1,000,000 - 6.00	7,000,000 - 6.85
11,000 - 4.04	71,000 - 4.85	410,000 - 5.61	1,100,000 - 6.04	7,100,000 - 6.85
12,000 - 4.08	72,000 - 4.86	420,000 - 5.62	1,200,000 - 6.08	7,200,000 - 6.86
13,000 - 4.11	73,000 - 4.86	430,000 - 5.63	1,300,000 - 6.11	7,300,000 - 6.86
14,000 - 4.15	74,000 - 4.87	440,000 - 5.64	1,400,000 - 6.15	7,400,000 - 6.87
15,000 - 4.18	75,000 - 4.88	450,000 - 5.65	1,500,000 - 6.18	7,500,000 - 6.88
16,000 - 4.20	76,000 - 4.88	460,000 - 5.66	1,600,000 - 6.20	7,600,000 - 6.88
17,000 - 4.23	77,000 - 4.89	470,000 - 5.67	1,700,000 - 6.23	7,700,000 - 6.89
18,000 - 4.26	78,000 - 4.89	480,000 - 5.68	1,800,000 - 6.26	7,800,000 - 6.89
19,000 - 4.26	79,000 - 4.90	490,000 - 5.69	1,900,000 - 6.28	7,900,000 - 6.90
20,000 - 4.30	80,000 - 4.90	500,000 - 5.70	2,000,000 - 6.30	8,000,000 - 6.90
21,000 - 4.32	81,000 - 4.91	510,000 - 5.71	2,100,000 - 6.32	8,100,000 - 6.91
22,000 - 4.34	82,000 - 4.91	520,000 - 5.72	2,200,000 - 6.34	8,200,000 - 6.91
23,000 - 4.36	83,000 - 4.92	530,000 - 5.72	2,300,000 - 6.36	8,300,000 - 6.92
24,000 - 4.38	84,000 - 4.92	540,000 - 5.73	2,400,000 - 6.38	8,400,000 - 6.92
25,000 - 4.40	85,000 - 4.93	550,000 - 5.74	2,500,000 - 6.40	8,500,000 - 6.93
26,000 - 4.42	86,000 - 4.93	560,000 - 5.75	2,600,000 - 6.42	8,600,000 - 6.93
27,000 - 4.43	87,000 - 4.94	570,000 - 5.76	2,700,000 - 6.43	8,700,000 - 6.94
28,000 - 4.45	88,000 - 4.94	580,000 - 5.76	2,800,000 - 6.45	8,800,000 - 6.94
29,000 - 4.46	89,000 - 4.95	590,000 - 5.77	2,900,000 - 6.46	8,900,000 - 6.95
30,000 - 4.48	90,000 - 4.95	600,000 - 5.78	3,000,000 - 6.48	9,000,000 - 6.95
31,000 - 4.49	91,000 - 4.96	610,000 - 5.79	3,100,000 - 6.49	9,100,000 - 6.96
32,000 - 4.51	92,000 - 4.96	620,000 - 5.79	3,200,000 - 6.51	9,200,000 - 6.96
33,000 - 4.52	93,000 - 4.97	630,000 - 5.80	3,300,000 - 6.52	9,300,000 - 6.97
34,000 - 4.53	94,000 - 4.97	640,000 - 5.81	3,400,000 - 6.53	9,400,000 - 6.97
35,000 - 4.54	95,000 - 4.98	650,000 - 5.81	3,500,000 - 6.54	9,500,000 - 6.98
36,000 - 4.56	96,000 - 4.98	660,000 - 5.82	3,600,000 - 6.56	9,600,000 - 6.98
37,000 - 4.57	97,000 - 4.99	670,000 - 5.83	3,700,000 - 6.58	9,700,000 - 6.99
38,000 - 4.58	98,000 - 4.99	680,000 - 5.83	3,800,000 - 6.58	9,800,000 - 6.99
39,000 - 4.59	99,000 - 4.99	690,000 - 5.84	3,900,000 - 6.59	9,900,000 - 6.99
40,000 - 4.60	100,000 - 5.00	700,000 - 5.85	4,000,000 - 6.60	10,000,000 - 7.00
41,000 - 4.61	110,000 - 5.04	710,000 - 5.85	4,100,000 - 6.61	11,000,000 - 7.04
42,000 - 4.62	120,000 - 5.08	720,000 - 5.86	4,200,000 - 6.62	12,000,000 - 7.08
43,000 - 4.63	130,000 - 5.11	730,000 - 5.86	4,300,000 - 6.63	13,000,000 - 7.11
44,000 - 4.64	140,000 - 5.15	740,000 - 5.87	4,400,000 - 6.64	14,000,000 - 7.15
45,000 - 4.65	150,000 - 5.18	750,000 - 5.88	4,500,000 - 6.65	15,000,000 - 7.18
46,000 - 4.66	160,000 - 5.20	760,000 - 5.88	4,600,000 - 6.66	16,000,000 - 7.20
47,000 - 4.67	170,000 - 5.23	770,000 - 5.89	4,700,000 - 6.67	17,000,000 - 7.23
48,000 - 4.68	180,000 - 5.26	780,000 - 5.89.	4,800,000 - 6.68	18,000,000 - 7.26
49,000 - 4.69	190,000 - 5.28	790,000 - 5.90	4,900,000 - 6.69	19,000,000 - 7.28
50,000 - 4.70	200,000 - 5.30	800,000 - 5.90	5,000,000 - 6.70	20,000,000 - 7.30
51,000 - 4.71	210,000 - 5.32	810,000 - 5.91	5,100,000 - 6.71	30,000,000 - 7.48
52,000 - 4.72	220,000 - 5.34	820,000 - 5.91	5,200,000 - 6.72	40,000,000 - 7.60
53,000 - 4.72	230,000 - 5.36	830,000 - 5.92	5,300,000 - 6.72	50,000,000 - 7.70
54,000 - 4.73	240,000 - 5.38	840,000 - 5.92	5,400,000 - 6.73	60,000,000 - 7.78
55,000 - 4.74	250,000 - 5.40	850,000 - 5.93	5,500,000 - 6.74	70,000,000 - 7.85
56,000 - 4.75	260,000 - 5.42	860,000 - 5.93	5,600,000 - 6.75	80,000,000 - 7.90
57,000 - 4.76	270,000 - 5.43	870,000 - 5.94	5,700,000 - 6.76	90,000,000 - 7.95
58,000 - 4.76	280,000 - 5.45	880,000 - 5.94	5,800,000 - 6.76	100,000,000 - 8.00
59,000 - 4.77	290,000 - 5.46	890,000 - 5.95	5,900,000 - 6.77	200,000,000 - 8.30
60,000 - 4.78	300,000 - 5.48	900,000 - 5.95	6,000,000 - 6.78	300,000,000 - 8.48

The Keeping Quality Test. The milk is kept in special bottle at a given temperature such as 60°F to 70°F, and examined every 8 to 12 hours until it becomes sour or putrid. As a general method for controlling the hygienic quality of the milk, this test performs a useful function, but the fact that the end-point is entirely subjective necessarily exposes the result to a very large experimental error.

The presence of coliform bacilli in small numbers in water or milk is not in itself objectionable. It is merely an index of the possible accompanying presence of pathogenic organisms that it is of importance. In milk, the coliform test cannot be used as an index of direct excretal pollution, for though it is true that if manure gains access to milk;coliform organisms will probably be found, the reverse conclusion does not hold true. There are so many other sources on the farm for these organisms that their presence in milk cannot be held to justify the conclusion that the milk has necessarily been contaminated with excretal material. The coliform test on milk fails to provide that specific qualitative information. It may serve a useful purpose in the examination of the highest quality raw milk, since such milk often fails to show the presence of coliform bacilli in 1 c.c. quantities even several hours after production. Its use, however, in this connection is purely empirical, merely serving as an index of contamination of the milk from environmental sources. Again the test may be of some empirical value in the control of pasteurization, since the practical absence of coliform bacilli from pasteurized milk examined immediately after processing affords, except with very clean milks, a fairly good indication that pasteurization has been carried out efficiently.

The test for coliform bacteria may be done with either solid or liquid media. The Presumptive Test is done as follows:

Liquid Media - Inoculate a series of 2% brilliant green lactose peptone bile or of formate ricinoleate broth fermentation tubes with appropriate graduated quantities (decimal multiples or fractions of 1 c.c., such a 10 c.c., 1 c.c., 0.1 c.c., 0.01 c.c. etc) of milk to be tested. Five tubes of each dilution used are recommended. In order to be certain of obtaining a definite result it is essential that the dilutions be such that at least one positive and one negative tube result be obtained. To satisfy this requirement, it may be necessary to plant 3 or even more dilutions. When, however, the purpose of the test is merely to determine whether a specific density of organisms is exceeded, only one or two dilutions may be required. In pasteurization control, for example, 5 tubes, each inoculated with 1 c.c. (or 10 c.c.) of sample are recommended in those cases where previous experience has shown that results are likely to be negative. These tubes are incubated at 37° C. for 48 hours. The formation, within this period, of gas constitutes a positive presumptive test.

Solid Media - Place not more than 1 c.c. of sample in a petri dish. Add 10 to 15 c.c. of violet red bile agar, or desoxycholate agar, which has been liquified and cooled to a temperature of 40° to 44° C., and mix thoroughly by tilting and rotating the dish. After the agar and sample mixture has solidified, 3 or 4 c.c. of agar is poured over it to form a film of medium which covers the entire surface of the solid mixture. The purpose of the cover is to eliminate the possibility of the occurrence of surface colonies of coliform organisms, for the appearance presented by such colonies is often so atypical, that they may not readily be recognized. When the agar has solidified, the plates are placed in an inverted position in an incubator at 37° C. for a period of 20-24 hours. The appearance, at this time, of typical dark-red colonies of at least .5 mm. in diameter constitutes a positive presumptive test. These colonies should be counted and the number recorded.

The Completed Test is done as follows:

From positive fermentation tubes: Streak an eosin methylene blue (E.M.B.) or endo agar plate from the fermentation tube. Incubate at 37° C. for 18 to 24 hours. From this plate fish one or more typical colonies, or if no typical colonies are present, two or more colonies considered most likely to be of the coliform group, and transfer each to a nutrient agar slant and to a lactose broth fermentation tube. Incubate agar slant at 37° C. for 24 hours, and lactose broth at 37° C. for 48 hours. The formation of gas in the lactose broth and the demonstration, upon microscopic examination of the agar culture, of the presence of gram-negative, non-spore-forming, rod-shaped bacteria, and of the absence of spore-forming bacilli, constitute a positive complete test.

From positive selective agar plates: Fish a deep typical (dark red) colony from the selective agar plate and transfer to a lactose broth fermentation tube, and incubate at 37° C. As soon as possible after gas appears, the complete procedure as followed for the above "Positive Fermentation Tube" is carried out. If no gas is formed within 48 hours, the colony fished must be considered to have contained no coliform organism.

The Methylene Blue Reduction Test. The general technique of this test is to place 10 c.c. of milk into a sterile tube and add 1 c.c. of standard methylene blue solution (final concentration 1 to 300,000). A sterile rubber cork is then inserted and the tube is inverted once or twice so as to mix the dye with the milk. Then the tube is incubated in a constant temperature water-bath at 37° C. in complete darkness. After 5 minutes, the tube is inverted once to promote uniform creaming. Thereafter it is not disturbed until the end of the test. It is examined at intervals up to 8 hours. (The English School inverts the

tube every half hour). When the blue color of the dye is completely decolorized the test is ended. The methylene blue reduction is the time between placing the tube in the bath and the disappearance of the blue color from the milk. Because of the uneven reduction in some tubes, the end point may be recorded when four-fifths of the contents of the tube has turned white.

The reductase test depends on the presence of the enzyme reductase in the milk. In a general way, the amount of reductase correlates with the number of bacteria, age and cleanliness of the milk. It is a crude index of its general sanitary conditions. The reductase in milk is probably of bacterial origin. It has the property of decolorizing methylene blue by reducing it. The reduction time of the methylene blue depends on the oxygen consuming ability of the microorganisms which are alive and grow during the period of incubation. If no oxygen from the air is allowed to enter the tube, the oxygen consumed by the microorganisms is derived from the reduction of the methylene blue by the reductase. Therefore the introduction of oxygen into the test tube will vitiate the result of the test. Thus the reduction depends partly on (1) the availability of free oxygen from the air (2) the oxygen consuming ability of the bacteria (3) the production of reducing substances by the organism, (4) the presence of a natural reducing system in the milk itself. If the rate of reduction of the methylene blue depends partly on the number of organisms and partly on their metabolic activity, the test affords a very good index of both the bacterial cleanliness of the milk, and its keeping quality. The chief value of this test lies in affording a fairly rapid means of assessing the general hygienic quality of raw mixed milk.

The limitations of the methylene blue reduction test for estimating the sanitary quality of milk are:

1. Does not take into consideration the action of the psychrophilic organisms(grow and reproduce favorably at low temperature) and the thermophilic organisms.

2. The reducing activity lessens as time proceeds.

3. Seasons affect the results of this method; the reduction time is shorter in summer than in winter.

4. Varying amounts of cream will effect the reduction time.

5. Varying influences of different species of bacteria capable of growing in milk at this temperature on the oxidation-reduction potentials of the milk, presumably because of differing oxygen consumption rates.

6. Bacteria being swept out of the milk into the cream layer by the rising butter fat.

7. Not useful for pasterurized milk.

8. Does not indicate variation from normal milk which might be caused by mastitis, colostrum, lactation.

Comparison of the Reductase Test and the Plate Count.

1. There is probably not much difference in the expense of doing a reductase test than a plate count. Whatever difference there might be would accumulate on the side of the plate count.

2. The reductase test gives no specific information about bacterial content, but in a general sense it does give good indications as to the quality of raw milk, i.e. its degree of contamination and its keeping quality. The plate count does give specific information of the bacterial content if one wishes to carry out a complete procedure.

3. It takes more skill to perform a plate count than a reductase test. The reductase test is simple enough for any farmer or dairyman to perform; the plate count requires some laboratory training.

4. Although the plate count may give information about certain types of organisms, it is indeed limited in the ability to give even approximate accurate figures as to multitude of bacteria. Therefore the reductase test which gives a dynamic indication of the bacterial activity in the milk is as satisfactory as the plate count for raw milk in giving numerical values. There are many microorganisms which will not grow in the agar plate, but will be active in the reductase test.

5. For pasteurized milk the plate count is used in preference to the reductase test.

Both are inadequate, since thermophile will not grow efficiently on agar at 37° C. whereas the dynamic activity of these bacteria is not indicated in the reductase test at 37° C.

6. In many ways the two tests supplement one another.

7. The reductase test is not good for testing pasteurized milk because bacteria grow so much quicker in pasteurized milk than in raw milk.

8. Reductase test is not affected by clumping of bacteria; plate count is.

The English method for the reductase test differs from the American in that the tubes are inverted every half hour until decolorization take place. The advantage claimed by this method is that it gives a more definite end point. When decolorization starts, it does not take long for reduction to conclude. The inversion is for the purpose of distribution of cream and bacteria. If not disturbed, the cream will rise to the top and sweep the bacteria to the surface with it. Thus, if the bacteria are concentrated in one area, the reduction time is prolonged. The Americans do not all agree with this method. They believe that bacteria, concentrated in the cream do not materially alter the reduction time to warrant the inverting procedure. They also hold the opinion that shaking or inverting the tube may introduce oxygen into the milk and further vitiate the results.

Grading by Methylene Blue Reduction Test. Since the reduction time in the methylene blue test depends on the oxygen-consuming power of the bacteria which grow during incubation, it is indirectly a quantitative index of the bacterial population of the milk before incubation. A suggested classification for quickly grading raw milk supplies follows:

Class 1. Excellent, not decolorized in 8 hours.
Class 2. Good, decolorized in less than 8 hours but not less than 6 hours.
Class 3. Fair, decolorized in less than 6 hours but not less than 2 hours.
Class 4. Poor, decolorized in less than 2 hours.

A classification in terms of numbers of bacteria which is losing favor in many laboratories due to the inaccuracies involved follows -

Decolorization Time Hours	Minutes	Estimated No. of Bacteria per c.c.	Decolorization Time Hours	Minutes	Estimated No. of Bacteria per c.c.
		CLASS IV			CLASS III
0	0	25,000,000	0	30	4,600,000
0	5	20,000,000	0	45	4,000,000
0	10	15,000,000	1	0	3,400,000
0	15	10,000,000	1	15	2,800,000
0	20	5,000,000	1	30	2,200,000
			1	45	1,600,000
			2	0	1,000,000
		CLASS II			CLASS I
2	15	941,000	5	45	176,000
2	30	884,000	6	0	152,000
2	45	827,000	6	15	127,000
3	0	770,000	6	30	100,000
3	15	713,000	6	45	75,000
3	30	656,000	7	0	50,000
3	45	599,000			
4	0	542,000			CLASS 0
4	15	485,000			
4	30	428,000	7	15	44,000
4	45	471,000	7	30	39,000
5	0	314,000	7	45	34,000
5	15	257,000	7	0	29,000
5	30	200,000	8	15	24,000
			8	30	19,000
			8	45	14,000
			9	0	10,000

Decolorization Time Hours	Minutes	Estimated No. of Bacteria per c.c.
	CLASS 00	
9	30	9,100
10	0	8,200
10	30	7,300
11	0	6,400
11	30	5,500
12	0	4,600
12	30	3,700
1[illegible]	0	2,800
1[illegible]	30	1,900
14	0	1,000

SUMMARY

Class IV	5,000,001	to	20,000,000 and over	
Class III	1,000,001	to	5,000,000	
Class II	200,000	to	1,000,000	
Class I	50,001	to	200,000	
Class 0	10,001	to	50,000	
Class 00	1,001	to	10,000	

Test for Bacterial Spores. Since spore bearing bacteria in milk are derived originally from cow manure, dust, or dirty utensils, the presence of these organisms indicates contamination from the above sources. Certified milk usually shows no evidence of anaerobic spore-bearing bacteria except in occasional tubes. The cleanliness of certified milk is checked by plate count, microscopic test, methylene blue reduction test, sediment test and coliform test, but the total count of bacteria fails to indicate the strictness of cleanliness because the numbers present may be due largely to multiplication, or to other factors than manure. The coliform test fails because the organisms may multiply in milk (doubling their numbers in 20 minutes under favorable conditions) and therefore may not indicate the degree of manurial contamination. The sedimentation test merely indicates the amount of dirt present, but filters and centrifuges may vitiate this estimate. The microscopic test may give qualitative evidence of the various types of bacteria but not an index of the number of spores. Pasteurized milk cleanliness is tested by the above tests (excepting the methylene blue reduction test), but pasteurization may kill the coliform bacteria and therefore this index could not be used in testing the cleanliness of pasteurized milk (not considering post-pasteurizing contamination).

The spore test overcomes all the above limitations for estimating cleanliness in certified and pasteurized milk. The anaerobic spore-bearing bacteria do not multiply under the conditions for keeping milk. They are not destroyed by pasteurization and they cannot be filtered out by any ordinary filtering device. Thus the spore test is not only superior for raw milk as a detector for manurial contamination, but also for pasteurized milk.

The general method of the spore test is as follows: 10 c.c. of milk are placed into a tube containing 2 c.c. of sterile vaseline. This is heated to 80° C for 15 minutes. In this way the non-spore bearing bacteria are destroyed, all gases (oxygen) are driven from the milk, and the melted vaseline rises to the surface forming an air tight seal over the milk (anaerobes will grow only in absence of molecular oxygen). Thus the anaerobes can grow if incubated for 72 hours at 37° C. The formation of gas, coagulation or digestion of the milk means that the anaerobes are present and growing. The presence of gas is detected by the pushing up of the vaseline seal.

Phosphatase Test. The phosphatase test depends upon the fact that raw cow's milk contains an enzyme called phosphatase which when heated to 14[illegible]° C for [illegible] minutes will be destroyed. The remarkable character of this enzyme is that its destruction point corresponds so very closely with the standard time and temperature designated for pasteurization. The discovery of the phosphatase marked a milestone in the development of milk sanitation. So sensitive is the phosphatase enzyme to the standard temperature-time action of pasteurization that the enzyme will be found not to be destroyed when the milk is held at 14[illegible]° F for 25 minutes, 141½° F for 30 minutes, or if as little as 1/10 of 1% of raw milk is added to pasteurized milk.

The technique of the phosphatase test is concerned with the procedure of detection, the presence or absence of traces of phosphatase after milk was supposed to be pasteurized. The rationale of the procedure is as follows: When the enzyme is mixed with disodium phenyl phosphate, the phenyl phosphate radical is hydrolyzed to produce free phosphoric acid and free phenol. But the enzyme will only be present in milk if it is not properly pasteurized. In order to detect the presence of the colorless phenol, some indicator must be used which will colorize it. Such an indicator is 2.6 dibromo-quinone-chloroimide. It causes the phenol to develop a blue color. If no phenol is present the addition of the indicator will give a brown or gray color to the milk.

The procedure is as follows: (1) Add 5.0 c.c. of buffered substrate (this contains disodium phenyl phosphate, sodium borate buffer, and magnesium) to [illegible] c.c. of milk sample. [illegible] Incubate 10 minutes in a water bath at 37° C. (3) Remove from bath and add 6 drops BCC

solution (dibromo-quinone-chloroimide). Shake well. (4) After 5 minutes, compare the color with opaque standards. (5) Extract the blue indophenol formed in the milk with the butyl alcohol. Add 2 c.c. of the alcohol to test gube and invert slowly 10 times. Allow liquid to separate into layers. Any blue or blue green in the alcohol is indicative of improper pasteurization.

Interpretation of the Test

1. Properly pasteurized milk will be gray or brown
2. Properly pasteurized cream will be gray or white
3. Raw milk or cream will be an intense blue. Intensity of color is proportional to degree of underpasteurization
4. The test will detect .1% raw milk mixed with pasteurized milk, or one degree below standard temperature, or 5 minutes under heating during pasteurization
5. Any blue color the intensity of which is 2 Scharer units or less is considered satisfactory pasteurization.

Difficulties Associated with Pasteurization

1. Maintaining an even temperature in the vat
2. Keeping thermometer properly functioning
3. Preventing leakage of valves
4. Preventing splashing of milk
5. Maintaining pasteurization temperature in foam
6. Preventing growth of thermophilic bacteria.

Advantages of Pasteurization

1. Decreases epidemic from milk source
2. Increases keeping quality of milk
3. Does not destroy the souring organisms.

The time and temperature standard for pasteurization is determined by the time-temperature death point of the tubercle bacilli.

References: (1) Principles of Bacteriology and Immunology - Topley and Wilson

(2) Standard Methods - American Public Health Association

(3) Preventive Medicine and Hygiene - Rosenau

(4) U. S. P. H. S. Standard Milk Code 1939.

Facts About Milk

A. PRODUCTION AND CONSUMPTION

Milk is produced on about 70% of all farms in United States in herds of 1 to 100 cows or more. In the South a lesser percent of farms produce milk than is indicated above.

The number of Milch Cows on Farms and Total Annual Production in U. S. 1924-37 (2)

Year	Milch Cows on Farms	Milk Production Per Cow	Total Milk Production on Farms
1924	21,371,000	4,074 pounds	87,069,000,000
1925	21,389,000	4,132 "	88,375,000,000
1926	21,221,000	4,330 "	91,887,000,000
1927	21,145,000	4,460 "	94,307,000,000
1928	21,219,000	4,520 "	95,910,000,000
1929	21,618,000	4,578 "	98,976,000,000
1930	22,217,000	4,510 "	100,190,000,000
1931	23,105,000	4,461 "	103,064,000,000
1932	24,112,000	4,307 "	103,852,000,000
1933	25,062,000	4,180 "	104,753,000,000
1934	25,198,000	4,029 "	101,528,000,000
1935	24,276,000	4,178 "	101,421,000,000
1936	23,988,000	4,301 "	103,183,000,000
1937	23,710,000	4,350 "	103,132,000,000

Production and Uses of Milk in the United States (2)

	Quantity of Product Manufactured	Whole Milk Used	Percentage of Total Milk Produced
Creamery Butter	1,629,407,000	33,096,000,000	31.22
Farm Butter	522,980,000	10,597,000,000	10.00
Cheese	642,551,000	6,446,000,000	6.08
Condensed Milk (case)	47,361,000	104,000,000	.10
Condensed Milk (bulk)	179,219,000	424,000,000	.40
Evaporated Milk (case)	2,043,759,000	4,385,000,000	4.14
Dry Powdered Milk	18,180,000	137,000,000	.13
Dry or Powdered Cream	178,000	3,000,000	
Malted Milk	18,495,000	50,000,000	.05
Ice Cream	243,551,000	3,629,000,000	3.42
Total Used in Manufacturing		57,668,000,000	54.41
Milk			
Consumed in Cities and Villages		31,848,000,000	30.04
Consumed on Farms where Produced		12,522,000,000	11.81
Fed To Calves		2,794,000,000	2.63
All Other Uses		1,177,000,000	1.11
Grand Total		106,009,000,000	100.00

Annual Per Capita Consumption of Milk, Butter, Cheese, etc. in U. S. 1927-36 (2)

Year	Milk Used in Cities	Butter (farm and factory)	Cheese, except cottage, pot & bakers	Evaporated Milk	Condensed Milk	Ice Cream
1927	39.7 Gal.	17.5 Lbs.	4.5 Lbs.	11.5 Lbs.	2.6 Lbs	2.02 Gal.
1928	39.8 "	17.2 "	4.5 "	12.4 "	2.5 "	2.02 "
1929	40.8 "	17.3 "	4.6 "	13.7 "	2.7 "	2.14 "
1930	40.1 "	17.3 "	4.6 "	13.6 "	2.7 "	1.96 "
1931	39.0 "	18.1 "	4.5 "	13.6 "	2.3 "	1.68 "
1932	39.1 "	18.3 "	4.4 "	14.3 "	1.8 "	1.24 "
1933	38.6 "	17.9 "	4.5 "	14.1 "	1.7 "	1.18 "
1934	36.1 "	18.3 "	4.8 "	15.3 "	1.7 "	1.42 "
1935	37.0 "	17.3 "	5.2 "	16.7 "	1.8 "	1.56 "
1936	38.2 "	16.6 "	5.4 "	16.6 "	1.9 "	1.90 "

B. COMPOSITION

Average Composition:

	Cow		Human	
Water	87.34	percent	87.58	percent
Fat	3.75	"	3.74	"
Sugar (Lactose)	4.76	"	6.37	"
Protein - total	3.40	"	2.01	"
Caseinogen	3.00	"	0.80	"
Lactalbumen	0.40	"	1.21	"
Minerals	0.75	"	0.30	"
Total Solids	12.66	"	12.42	"
Total Solids not Fat	8.91	"	8.68	"
Specific Gravity	1.0313	"	1.0298	"

There are 20 calories to each ounce of milk

Milk has an amphoteric (either acid or alkaline) reaction, due to the mono- and di-phosphates which it contains.

Milk contains significant quantities of calcium, phosphorus, potassium, chlorine, sodium, sulphur, and magnesium. It contains minute quantities of iodine, iron, copper and manganese.

"Richness" of milk means fat content. Holstein cows produce milk with low fat content; Jersey and Guernsey cows produce milk with high fat content.

Vitamins in Milk

Milk is rich in vitamin A; relatively rich in vitamin B; less dependable for vitamin C; relatively poor in vitamin D; fair to good in vitamin E and rich in vitamin G.

Most vitamins in milk are stable and heat resistant, but vitamin C is unstable and destroyed by heating. The vitamins A and D are found in the butter fat of the milk. The vitamin D content probably depends on the prevalence of sunshine and on the intake of this vitamin by the cows, therefore the milk contains more of this vitamin in summer than winter unless the cows are artificially supplied with vitamin D.

Milk also contains enzymes, antibodies, cells, gases, acids and other substances in minute quantities.

An enzyme is an organic substance secreted by living cells which induces chemical changes in other substances, but remains apparently unchanged itself. Milk contains many enzymes such as, reductase, phosphatase, peroxidase, galactose, lactokinase, lipase, catalose,and diastase. Some of the milk tests depend on the ferments found in milk. Example:

1. The methyline blue reductase test depends on the amount of reductase (which is probably of bacterial origin) in the milk. There is a correlation between the amount of reductase present in milk and the number of bacteria present.
2. The phosphatase test depends upon the fact that the enzyme phosphatase which is normally found in milk will be destroyed when the milk is heated to approximately 143°C. for approximately 30 minutes. Therefore it is a good test to determine the adequacy of the pasteurizing process.

Heat Destroys Enzymes.

Each enzyme has its own thermal destruction point. Catalase and peroxidase were at one time used in testing milk. Galactase and lactokinase aid in breaking down proteins,lipase aids in breaking down fats, and diastase aids in breaking down starches.

White cells (leucocytes) are always found in great numbers in milk - (1) At the end of lactation, (2) Near time of calving, (3) During periods of excitement, (4) During an infection of the udder.

Whenever more than 500,000 leucocytes are found to each c.c. of milk, one must suspect that an abnormal condition exists.

Colostrum differs markedly from milk in appearance, quality, composition and function. It contains much antibodies. Calves do not survive well without it. They may succumb to intestinal and kidney infections.

Many drugs are excreted in milk; therefore cows producing certified milk are not allowed to graze promiscuously since they may feed on poisonous weeds.

Milk contains large fat droplets. Heating to 65° C. causes the droplets to break up. When

milk is atomized under 1500 pounds pressure at a temperature of 75° C. it becomes homogenized, that is, the fat droplets are broken into such small globules that they remain suspended in the milk and so the fat does not separate out on allowing the milk to stand. This process applied to cream increases its viscosity and apparent volume so that cream containing 20% butter fat may appear to have 30% butter fat.

Heat hinders the rising of fat droplets. If heated above 63° C. for 40 minutes or longer, the formation of the cream line is noticeably retarded and therefore the richness of milk cannot be judged by the cream layer.

C. MILK STANDARDS (See La. Milk Code & U.S.P.H.S. Milk Code)

Louisiana Milk Code

Milk standards are usually based on the minimum qualifications necessary to insure good safe milk. These qualifications are concerned with

1. Physical properties of milk, i.e. specific gravity, temperature, taste, odor, color, etc.
2. Chemical properties of milk, ie., percent of butter fat and total solids.
3. Bacteriological properties, i.e., number of microorganisms and absence of pathogens.
4. Sanitary properties of means of production, preservation, distribution, and consumption of the milk, i.e. mode of dairying, pasteurization, bottling, etc.

The Louisiana Milk Code is an adaptation of the U.S.P.H.S. Standard Milk Code. A few changes were made in accordance to local needs. The difference between the two codes are:

1. La. State: Milk contains not less than $8\frac{1}{2}\%$ milk solids not fat; $3\frac{1}{2}\%$ milk fat
   U.S.P.H.S.: Milk contains not less than 8% milk solids not fat; $3\frac{1}{4}\%$ milk fat.
2. La. State: Skimmed milk contains less than $3\frac{1}{2}\%$ milk fat
   U.S.P.H.S.: Skimmed milk contains less than $3\frac{1}{4}\%$ milk fat.
3. La. State: Buttermilk contains not less than $8\frac{1}{2}\%$ milk solids not fat
   U.S.P.H.S.: Buttermilk contains not less than 8% milk solids not fat.
4. La. State: Does not prohibit ungraded milk from being sold
   U.S.P.H.S.: Does prohibit ungraded milk from being sold.
5. La. State: Added the following paragraph to the regulation on Labeling and Placarding which does not appear in U.S.P.H.S. Code: Terms or words used on milk bottle caps or milk bottles such as fresher, better, the best, the safest, special, natural, hygienic, baby milk, and similar terms are prohibited. No manufacturer or agent of dairy supplies and milk bottle caps shall have in their possession, place orders for, ship into the municipality, parish or health district, or assist any other person to secure any dairy supplies and printed milk bottle caps, not approved by the health officer having jurisdiction.
6. La. State: Does not allow tight wood floors in dairy barns if the milk is to be pasteurized
   U.S.P.H.S.: Does allow tight wood floors in dairy barns if the milk is to be pasteurized.
7. La. State: Added the following provisions which do not appear in the U.S.P.H.S. Code:
   Insanitary Handling of Milk. Milk produced and handled under conditions which violate any of the provisions of these regulations shall be considered as produced and handled in an improper, unclean and insanitary manner. Any conditions, or practices, existing or found in operation at a dairy or milk plant which may be judged as immediately dangerous to the public health shall be considered sufficient ground for immediate closure of the dairy or milk plant.
   No cows shall be fed on any substance in a state of fermentation and putrefaction, swill or unwholesome food. No dairyman shall buy for dairy purposes or bring into his dairy farm, any wet, moist, or damp brewery mash, waste or grain nor shall be maintained in his possession in or about the dairy or dairy farm any such wet,moist or damp brewery mash, waste or grain.
   Rat Proofing. Where rat proofing regulations are in existence, they shall apply in the construction of buildings in which the production, handling and sale of milk and certain milk products are conducted, and which conform to these regulations.
8. La. State: Added the following provisions which do not appear in U.S.P.H.S. Code:
   Minimum Regulations. The regulations governing the production, handling and sale of milk and certain milk products herein enacted represent a minimum requirement.
   Local Ordinances Permitted. Louisiana Parishes and municipalities which wish to secure a better grade of milk through the enforcement of local milk grading ordinances may do so upon approval of such ordinances by the State Board of Health.
   Supplementary Grading Prescribed and Regrading Authorized. In order that grades of milk and certain milk products shall be uniform throughout the State, the following specifications are prescribed.

D. ADULTERATION

If the law were to allow low total solids, it would encourage watering of milk. If it were to allow low fat and high total solids content, it would encourage skimming of milk, production from inferior cows, and poor feeding.

The ratio of fat content to total solids may give good information in detection of skimming of milk, but the fat-protein ratio is more reliable. The best method for detection of watering of milk is by the process of freezing - milk freezes at minus .554°C.

The addition of alkalies such as sodium carbonate or sodium bicarbonate is sometimes practiced to neutralize the acidity caused by fermentation, thus improving the taste and delaying curdling.

Condensed skim is sometimes added to increase the total solids in skimmed milk.

Chemical preservatives such as boric acid, salicylic acid, benzoic acid, benzoates, potassium bicarbonate, hydrogen peroxide, fluorides, formaldehyde, etc. are sometimes added to poorly produced milk. Such practices are violations of the law.

The laws against adulteration of milk are as forceful as against adulteration of any other food.

E. DECOMPOSITION

Almost all decomposition of milk is due to bacterial action.

1. Fermentation is decomposition of carbohydrates of the milk by such microorganisms as lactic acid bacillus, Streptococcus lactis, Bacillus Bulgaricus, Bacillus acidophilus, Bacillus coli, etc., with the production of lactic acid (sour taste) and the precipitation of casein. This is a harmless process if the milk is clean and safe. Fermentation can be represented as follows:

   Lactose (Milk Sugar) plus bacteria --- galactose plus glucose --- lactic acid plus carbon dioxide.

   An abnormal form of fermentation may occur by the action on the milk by Bacillus lactis vicose, Micrococcus Freudenreichii and several types of streptococci. This fermentation will produce slimy or ropy milk whose threads may be drawn out 10 feet long. This is not injurious when not due to infection. It is a delicacy in Norway.

   Alcohol fermentation is due to action of bacteria aided by yeast. This type of fermentation produces a liquid which is used as a beverage in Eastern Europe and Asia, and called Kumyss or Kefir.

2. Putrefaction is the decomposition of the milk protein by spore bearing bacteria and anaerobes, with the production of bitter taste, alkaline reaction due to peptones and soft slimy curds.

3. Saponification is the decomposition of milk fat which occurs by the action of alkali-forming bacteria which render milk alkaline, presumably by acting on the proteins and at the same time secreting the enzyme lipase which splits the fats into fatty acids. The combined effect is to saponify the fat, and convert the milk into a yellow translucent whey-like fluid. This action is not often seen, since the members of this group of bacteria are overgrown by members of other groups, which produce acid, coagulation and peptonization. Organisms of this group comprise bacteria alkaligenes, and some of the aerobic spore-bearers. Bitterness in milk may also be due to enzyme (lipase) action on butterfat in changing it into fatty acids.

4. Oxidation of milk while standing in the sunlight may cause a cardboard or metallic taste to develop. Not only may milk become bitter from putrefaction but also by improperly feeding cows with such vegetation as lupines, wormwoods, raw Swedish turnips, cabbage, etc. In these cases, milk is bitter when freshly drawn.

F. PASTEURIZATION

This is the process of heating every particle of milk or milk products to at least 143° F, and holding at such temperature for at least 30 minutes, or to at least 160° F, and holding at such temperature for at least 15 seconds, in approved and properly operated equipment. (U.S.P.H.S. Code) All pathogens will die by heating to 140° F. for 20 minutes, but the

pasteurizing process is adequately greater than this for safety. Most bacterial toxins will be destroyed at 179° F.

Boiling changes taste of milk by denaturing proteins and driving off gases.

Pasteurization does not change taste of milk.

The pellicle formed on heating milk is caused by the rapid drying of the upper layer. When milk is heated in a closed vessel no pellicle will form.

The various methods of pasteurization are - (1) Holding method - holding milk at 14?° F. for 30 minutes, (2) Flash method - heating milk to 160° F. for 15 seconds, (3) Continuous flow method - heating milk and then running it at a certain rate thru a series of tanks or metal coils, (4) Vat method - heating milk in a double walled vat or cauldron with coil until it reaches a desired degree and holding it for 30 minutes, after which it is cooled by sending cold water thru double wall or coil, and (5) Pasteurization in final container method - heating the milk in water bath after being bottled.

G. MISCELLANEOUS

1. Colored Milk

   a. Blue milk may be due to Bacillus cyanogens
   b. Red milk may be due to
      1) Blood from an injury or acute infection of udder
      2) Plants containing red pigment such as madder root
      3) Bacillus erythrogenes, B. prodigiosus and Sarcinae
      4) Yellow coloration of fat layer may be due to a fermentation process incited by the microorganism pseydomonas synxantha.

2. Soft curds are more digestible than hard curds. Natural soft curds are obtained from selected cows. Artificial soft curds are obtained by homogenizing milk between 100°C. and 104° C. at 3000 pounds pressure. Boiling softens curds. Adding small quantity of blood serum will soften curds thus a pathological udder may produce soft curds.

3. Germicidal Property of Milk. There are indications that in very high quality milk, the bacterial count will actually decrease for some hours if let stand at body temperature or less. A recent report from the University of Illinois showed that high quality milk kept at 50° F. showed no increase in count after 6 hours, and only doubled its bacterial count after 24 hours. The same milk at 60° F.maintained a stationary bacterial count for more than 4 hours, but in 24 hours increased in count by more than 30 times. The same milk kept at 70° F. doubled its count in 6 hours, and increased its count in 24 hours by more than 50 times. Poor quality milk showed no bacteriostatic nor bactericidal character. Heating milk to 75° C for 15 minutes or 80-90° C for 2 minutes will destroy the germicidal action of milk. Pasteurization does not affect the germicidal action of milk.

   The types of pathogenic bacteria that may be found in milk are those causing foot and mouth disease, malta fever, tuberculosis, anthrax, diphtheria, scarlet fever, septic sore throat, typhoid and paratyphoid fevers, and dysentery. Milk should not be sold from dairies where there is smallpox, meningitis or poliomyelitis.

   Milk from cows in heat, or in gestation may cause gastrointestinal disturbances.

H. MILK PRODUCTS

Cream may be pasteurized more effectively than milk because it may be heated to much higher temperatures than milk without changing its physical properties.

Butter may contain tuberculosis germs as long as 3 to 6 months after manufacture from original whole milk. Cold preserves rather than kills germs.

Butter is usually made from "ripened" cream, i.e., partially sour. Special cultures of microorganisms are sometimes added to give butter a particular flavor.

Butter should contain not less than 80% milk fat according to U.S. regulation. Renovated butter should contain not more than 16% moisture.

Butter turns rancid because fat changes into fatty acids. Rancid butter may be renovated by washing with skim milk or with water containing sodium bicarbonate which neutralizes

the acids. Rancid odors and tastes may be blown out with steam. Enzyme action aiding decomposition of fat may be stopped by adding hydroquinone, and advancing decomposition may be checked with chlorine or other preservatives. Renovated butter must be so labelled.

Fresh butter contains millions of microorganisms per gram. Bacterial counts diminish with time (85% in 2 weeks - 93% in 4 weeks). Butter may contain any of the pathogenic germs found in milk. Butter should be made from pasteurized cream and labelled pasteurized butter.

Butter may be scored in accordance with the following system:

45 points for flavor
25 points for grain (body)
15 points for color
10 points for salt
5 points for packing

Oleomargarine is vegetable and animal fats churned with milk. When it is churned with skimmed milk its vitamin content is decreased, especially vitamin A.

I. TESTS

1. To determine the percent of fat in butter. (1) Warm butter to 40° C and stir. (2) Put 10 c.c. into a graduated sedimentation tube (3) Centrifuge for 10 seconds (4) Measure and record (5) Add 5 c.c. of gasoline and mix (6) Centrifuge for 15-20 seconds. The gasoline dissolves the fat which rises. The non-fat portion sinks. (7) Measure and calculate the percent of fat.

2. To determine whether fats other than butter fat are present. (1) Detected by refractometer. Natural butter has a refractometer index at 40° C ranging from 1.4531 to 1.4562, usually about 1.4553. Reading outside of this range indicates other types of fats.

3. To determine presence of coloring matter. (1) Dissolve the butter in ether (2) Divide into two parts (3) Add to one part dilute hydrochloric acid (4) Add to other part dilute sodium hydroxide (5) The first part will demonstrate presence of azo dyes (6) The second part will demonstrate presence of vegetable dyes.

4. To distinguish butter from oleomargarine. (1) Put small piece in a spoon and melt; boil and stir. (2) Butter will not sputter but will produce much foam; oleomargarine will sputter but will produce little foam. (Refractometer method is better)

5. Babock Test - Determination of butter fat in milk. (1) Measure 17.6 c.c. of milk in pipette and transfer to test bottle (2) Measure 17.5 c.c. of commercial sulphuric acid and transfer slowly to test bottle while using a gentle rotary motion of test bottle during the mixing. (3) Mixing is complete when the curds are completely dissolved and the entire mass becomes dark brown. (Sulphuric acid dissolves protein but not the fat) (4) Centrifuge test bottle for 5 minutes to separate fat from acid solution. (5) Add hot water (130° F) to bring content in bottle up to the neck. (Heat and water aids in separating fat from acid solution) (6) Centrifuge test bottle for 2 minutes (7) Add more hot water so that the fat column is well above the zero mark on the graduated scale (8) Centrifuge again for 1 minute. Reading: The length of the fat column is measured by dividers (calipers). The spread of the dividers is maintained while one point is placed on the zero point on the graduated scale, while the other point falling on the graduated scale will indicate directly the percent of fat in the milk.

6. Mann's Test - Determination of % acidity in milk. (1) Mix the sample of milk thoroughly, then transfer 17.6 c.c. into a white cup. (2) Add 3 or 4 drops of phenophthalein (3) Fill the burette with one tenth normal (n/10) sodium hydroxide and record the reading. (4) Then let the sodium hydroxide run into the milk, drop by drop, stirring constantly (5) When pink color appears, discontinue sodium hydroxide (6) Read in tenths (on graduated scale of burette) the amount of alkali used, and divide by two. Move the decimal point one place to the left and the answer will be the correct amount of acid in the milk.

7. Lactometer Test - Determination of percent solids not fat, total solids, and adulteration in milk. (1) Mix sample thoroughly and have the temperature about 60° F (2) Pour enough of the mixed sample into the cylinder to float the lactometer. The cylinder should be about three-fourths full (3) Insert lactometer in the cylinder and see that it floats freely (4) Take reading as soon as the lactometer comes to rest. Read on a level with the surface and not where the milk strikes the side of the ste[m] as there will be a slight rise in the surface at this point (5) Record the lactome[ter]

reading and the temperature of the milk (6) Remix the sample and run a Babcock Test to ascertain the percent of butter fat present (7) By comparing the lactometer reading to chart, the amount of total solids will be estimated. Subtracting the percent butter fat (as found by Babcock Test) from total solids, the percent solids not fat is found.

United States Public Health Service Milk Code

Section 1. Definitions. The following definitions shall apply in the interpretation and the enforcement of this ordinance:

A. MILK. Milk is hereby defined to be the lacteal secretion obtained by the complete milking of one or more healthy cows, excluding that obtained within 15 days before and 5 days after calving, or such longer period as may be necessary to render the milk practically colostrum free; which contains not less than 8 percent of milk solids not fat, and not less than $3\frac{1}{4}$ percent of milk fat.

B. MILK FAT OR BUTTER FAT. Milk fat or butter fat is the fat of milk.

C. CREAM AND SOUR CREAM. Cream is a portion of milk which contains not less than 18 percent milk fat. Sour cream is cream the acidity of which is more than 0.20 percent, expressed as lactic acid.

D. SKIMMED MILK. Skimmed milk is milk from which a sufficient portion of milk fat has been removed to reduce its milk-fat percentage to less than $3\frac{1}{4}$ percent.

E. MILK OR SKIMMED MILK BEVERAGE. A milk beverage or a skimmed-milk beverage is a food compound or confection consisting of milk or skimmed milk, as the case may be, to which has been added a sirup or flavor consisting of wholesome ingredients.

F. BUTTERMILK. Buttermilk is a product resulting from the churning of milk or cream, or from the souring or treatment by a lactic acid or other culture of milk, skimmed milk, reconstituted skimmed milk, evaporated or condensed milk or skimmed milk, or milk or skimmed-milk powder. It contains not less than 8 percent of milk solids not fat.

G. VITAMIN D MILK. Vitamin D milk is milk the vitamin D content of which has been increased by a method and in an amount approved by the health officer.

H. RECONSTITUTED OR RECOMBINED MILK AND CREAM. Reconstituted or recombined milk is a product resulting from the recombining of milk constituents with water, and which complies with the standards for milk fat and solids not fat of milk as defined herein. Reconstituted or recombined cream is a product resulting from the combination of dried cream, butter, or butter fat with cream, milk, skimmed milk, or water.

I. GOAT MILK. Goat milk is the lacteal secretion, free from colostrum, obtained by the complete milking of healthy goats, and shall comply with all the requirements of this ordinance. The word "cows" shall be interpreted to include goats.

J. HOMOGENIZED MILK. Homogenized milk is milk which has been treated in such manner as to insure break-up of the fat globules to such an extent that after 48 hours storage no visible cream separation occurs on the milk and the fat percentage of the top 100 c.c. of milk in a quart bottle, or of proportionate volumes in containers of other sizes, does not differ by more than 5 percent of itself from the fat percentage of the remaining milk as determined after thorough mixing.

K. MILK PRODUCTS. Milk products shall be taken to mean and include cream, sour cream, homogenized milk, goat milk, vitamin D milk, buttermilk, skimmed milk, reconstituted or recombined milk and cream, milk beverages, skimmed-milk beverages, and any other product made by the addition of any substance to milk or any of these products and used for similar purposes and designated as a milk product by the health officer.

L. PASTEURIZATION. The terms "pasteurization", "pasteurized" and similar terms shall be taken to refer to the process of heating every particle of milk or milk products to at least 143° F., and holding at such temperature for at least 30 minutes, or to at least 160°F., and holding at such temperature for at least 15 seconds, in approved and properly operated equipment: Provided, that nothing contained in this definition shall be construed as disbarring any other process which has been demonstrated to be equally efficient and is approved by the State health authority.

M. ADULTERATED MILK AND MILK PRODUCTS. Any milk or milk product which contains any unwholesome substance, or which if defined in this ordinance does not conform with its definition, or which carries a grade label unless such grade label has been awarded by the health officer and not revoked, shall be deemed adulterated and misbranded.

N. MILK PRODUCER. A milk producer is any person who owns or controls one or more cows, a part or all of the milk or milk products from which is sold or offered for sale.

O. MILK DISTRIBUTOR. A milk distributor is any person who offers for sale or sells to another any milk or milk products for human consumption as such.

P. DAIRY OR DAIRY FARM. A dairy or dairy farm is any place or premises where one or more cows are kept, a part or all of the milk or milk products from which is sold or offered for sale.

Q. MILK PLANT. A milk plant is any place or premises or establishment where milk or

milk products are collected, handled, processed, stored, bottled, pasteurized, or prepared for distribution.

R. HEALTH OFFICER. The term "health officer" shall mean the health authority of the city of - - - - or his authorized representative.

S. AVERAGE BACTERIAL PLATE COUNT, DIRECT MICROSCOPIC COUNT, REDUCTION TIME, AND COOLING TEMPERATURE. Average bacterial plate count and average direct microscopic count shall be taken to mean the logarithmic average, and average reduction time and average cooling temperature shall be taken to mean the arithmetic average, of the respective results of the last four consecutive samples, taken upon separate days, irrespective of the date of grading or regrading.

T. GRADING PERIOD. The grading period shall be of such period of time as the health officer may designate within which which grades shall be determined for all milk and milk products, provided that the grading period shall in no case exceed 6 months.

U. PERSON. The word "person" as used in this ordinance shall mean "person, firm, corporation, or association."

V. AND/OR. Where the term "and/or" is used "and" shall apply where possible, otherwise "or" shall apply.

Section 2. The sale of adulterated, misbranded, or ungraded milk or milk products prohibited. No person shall within the city of - - - - or its police jurisdiction, produce, sell,offer, or expose for sale,or have in possession with intent to sell, any milk or milk product which is adulterated, misbranded, or ungraded. It shall be unlawful for any person, elsewhere than in a private home, to have in possession any adulterated,misbranded or ungraded milk or milk product.

Section 3. Permits. It shall be unlawful for any person to bring into or receive into the city of - - - - -, or its police jurisdiction, for sale, or to sell, or offer for sale therein, or to have in storage where milk or milk products are sold or served, any milk or milk product defined in this ordinance, who does not possess a permit from the health officer of the city of - - - - - - .

Only a person who complies with the requirements of this ordinance shall be entitled to receive and retain such a permit.

Such a permit may be suspended by the health officer, or revoked after an opportunity for a hearing by the health officer, upon the violation by the holder of any of the terms of this ordinance.

Section 4. Labeling and placarding. All bottles, cans, packages, and other containers enclosing milk or any milk product defined in this ordinance shall be plainly labeled or marked with (1) the name of the contents as given in the definitions in this ordinance; (2) the grade of the contents; (3) the word "pasteurized" only if the contents have been pasteurized; (4) the word "raw" only if the contents are raw; (5) the phrase "for pasteurization" if the contents are to be pasteurized; (6) the name of the producer if the contents are raw, and the name of the plant at which contents were pasteurized, if the contents are pasteurized, and (7) in the case of vitamin D milk, the designation "Vitamin D Milk" and the source of the vitamin D. The label or mark shall be in letters of a size, kind, and color approved by the health officer and shall contain no marks or words which are misleading.

Every restaurant, cafe, soda fountain, or other establishment serving milk or milk products shall display at all times, in a place designated by the health officer, a notice approved by the health officer, stating the lowest grade of milk and/or milk products served.*

Section 5. Inspection of dairy farms and milk plants for the purpose of grading or regrading. At least once during each grading period the health officer shall inspect all dairy farms and all milk plants within the city of - - - -, or its police jurisdiction. In case the health officer discovers the violation of any item of sanitation, he shall make a second inspection after a lapse of such time as he deems necessary for the defect to be remedied, but not before the lapse of 3 days; and the second inspection shall be used in determining the grade of milk and/or milk products. Any violation of the same item of this ordinance on two consecutive inspections shall call for immediate degrading. One copy of the inspection report shall be posted by the health officer in a conspicuous place upon an inside wall of one of the dairy farm or milk plant buildings, and said inspection report shall not be defaced or removed by any person except the health officer. Another copy of the inspection report shall be filed with the records of the health department.

Section 6. The examination of milk and milk products. During each grading period at least four samples of milk and cream from each dairy farm and each milk plant shall be

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* Cities in which only grade A pasteurized milk or only certified milk and grade A pasteurized milk are permitted to be sold may delete this paragraph and nevertheless be recognized as having adopted this ordinance.

taken on separate days and examined by the health officer. Samples of other milk products may be taken and examined by the health officer as often as he deems necessary. Samples of milk and milk products from stores, cafes, soda fountains, restaurants, and other places where milk or milk products are sold shall be examined as often as the health officer may require. Bacterial plate counts and direct microscopic counts shall be made in conformity with the latest standard methods recommended by the American Public Health Association.*

Examinations may include such other chemical and physical determinations as the health officer may deem necessary for the detection of adulteration, these examinations to be made in accordance with the latest standard methods of the American Public Health Association and the Association of Official Agricultural Chemists. Samples may be taken by the health officer at any time prior to the final delivery of the milk or milk products. All proprietors of stores, cafes, restaurants, soda fountains, and other similar places shall furnish the health officer, upon his request, with the names of all distributors from whom their milk and milk products are obtained. Bio-assays of the vitamin D content of vitamin D milk shall be made when required by the health officer in a laboratory approved by him for such examinations.

Whenever the average bacterial count, the average reduction time, or the average cooling temperature falls beyond the limit for the grade then held, the health officer shall send written notice thereof to the person concerned, and shall take an additional sample, but not before the lapse of 3 days, for determining a new average in accordance with section 1 (S). Violation of the grade requirement by the new average or by any subsequent average during the remainder of the current grading period shall call for immediate degrading or suspension of the permit, unless the last individual result is within the grade limit.

Section 7. The grading of milk and milk products. At least once every 6 months the health officer shall announce the grades of all milk and milk products delivered by all producers or distributors and ultimately consumed in the city of . . . . .,or its police jurisdiction. Said grades shall be based upon the following standards, the grading of milk products being identical with the grading of milk except that the bacterial standards shall be doubled in the case of cream, and omitted in the case of sour cream and buttermilk. Vitamin D milk shall be only of grade A or grade B pasteurized, certified, or grade A raw quality.

Certified milk-raw. Certified milk-raw is raw milk which conforms with the requirements of the American Association of Medical Milk Commissions in force at the time of production and is produced under the supervision of a medical milk commission and of the State board of health or of the city or county health officer of . . . .

Grade A raw milk. Grade A raw milk is raw milk the average bacterial plate count of which as determined under sections 1 (S) and 6 of the ordinance does not exceed 50,000 per cubic centimeter, or the average direct microscopic count of which does not exceed 50,000 per cubic centimeter if clumps are counted or 200,000 per cubic centimeter if individual organisms are counted, or the average reduction time of which is not less than 8 hours: Provided, that if it is to be pasteurized the corresponding limits shall be 200,000 per cubic centimeter, 200,000 per cubic centimeter, 800,000 per cubic centimeter, and 6 hours, respectively; and which is produced upon dairy farms conforming with all of the following items of sanitation.

Item 1r. Cows, tuberculosis and other diseases. Except as provided hereinafter, a tuberculin test of all herds and additions thereto shall be made before any milk therefrom is sold, and at least once every 12 months thereafter, by a licensed veterinarian approved by the State livestock sanitary authority. Said tests shall be made and reactors disposed of in accordance with the requirements approved by the United States Department of Agriculture, Bureau of Animal Industry for accredited herds. A certificate signed by the veterinarian or attested to by the health officer and filed by the health officer shall be evidence of the above test: Provided, that in modified accredited counties in which the modified accredited area plan is applied to the dairy herds the modified accredited area system approved by the United States Bureau of Animal Industry shall be accepted in lieu of annual testing.

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* Municipalities in which the adoption of legislation by reference is not considered legal may substitute the following wording: ". . in conformity with the regulations of the health officer (or board of health)." If the regulations then adopted by the health officer are equivalent to those contained in the reference thus replaced, they will not be considered as constituting a downward revision of the U.S. Public Health Service milk ordinance. All other references in this ordinance to standards and methods not specifically described may be treated in the same manner, such as the requirements of the American Association of Medical Milk Commissions under the definition of certified milk-raw, the requirements of the Bureau of Animal Industry relative to accredited herds and modified accredited areas in item 1r, and the U. S. Public Health Service milk code in section 15.

Within. . . . .* years after the adoption of this ordinance all milk and milk products consumed raw shall be from herds or additions thereto which have been found free from Bang's disease, as shown by blood serum tests for agglutinins against Brucella abortus made in a laboratory approved by the health officer. All such herds shall be retested at least every 12 months and all reactors removed from the herd. A certificate identifying each animal by number, and signed by the laboratory making the test, shall be evidence of the above test.

Cows which show an extensive or entire induration of one or more quarters of the udder upon physical examination, whether secreting abnormal milk or not, shall be permanently excluded from the milking herd. Cows giving bloody, stringy, or otherwise abnormal milk, but with only slight induration of the udder, shall be excluded from the herd until re-examination shows that the milk has become normal.

For other diseases such tests and examinations as the health officer may require shall be made at intervals and by methods prescribed by him, and any diseased animals or reactors shall be disposed of as he may require.

Item 2r. Dairy barn, lighting. A dairy or milking barn shall be required and in such sections thereof where cows are milked, windows shall be provided and kept clean and so arranged as to insure adequate light properly distributed , and when necessary shall be provided with adequate supplementary artificial light.

Item 3r. Dairy barn, air space and ventilation. Such sections of all dairy barns where cows are kept or milked shall be well ventilated and shall be so arranged as to avoid overcrowding.

Item 4r. Dairy barn, floors. The floors and gutters of such parts of all dairy barns in which cows are milked shall be constructed of concrete or other approved impervious and easily cleaned material provided that if the milk is to be pasteurized tight wood may be used, shall be graded to drain properly, and shall be kept clean and in good repair. No horses, pigs, fowl, calves, etc. shall be permitted in parts of the barn used for milking.

Item 5r. Dairy barn, walls and ceilings. The walls and ceilings of all dairy barns shall be whitewashed once each year or painted once every 2 years, or oftener, if necessary, or finished in an approved manner, and shall be kept clean and in good repair. In case there is a second story above that part of the barn in which cows are milked, the ceiling shall be tight. If the feed room adjoins the milking space, it shall be separated therefrom by a dust-tight partition and door. No feed shall be stored in the milking portion of the barn.

Item 6r. Dairy barn, cowyard. All cowyards shall be graded and drained as well as practicable and kept clean.

Item 7r. Manure disposal. All manure shall be removed and stored or disposed of in such manner as best to prevent the breeding of flies therein or the access of cows to piles thereof.

Item 8r. Milk house or room, construction. There shall be provided a milk house or milk room in which the cooling, handling, and storing of milk and milk products and the washing, bactericidal treatment, and storing of milk containers and utensils shall be done. (a) The milk house or room shall be provided with a tight floor constructed of concrete or other impervious material, in good repair, and graded to provide drainage. (b) It shall have walls and ceilings of such construction as to permit easy cleaning, and shall be well painted or finished in an approved manner. (c) It shall be well lighted and ventilated. (d) It shall have all openings effectively screened including outward-opening, self-closing doors, unless other effective means are provided to prevent the entrance of flies. (e) It shall be used for no other purposes than those specified above except as may be approved by the health officer; shall not open directly into a stable or into any room used for domestic purposes; shall, unless the milk is to be pasteurized, have water piped into it; shall be provided with adquate facilities for the heating of water for the cleaning of utensils; shall be equipped with two-compartment stationary wash and rinse vats, except that in the case of retail raw milk, if chlorine is employed as the principal bactericidal treatment, the three-compartment type must be used; and shall, unless the milk is to be pasteurized, be partitioned to separate the handling of milk and the storage of cleansed utensils from the cleaning and other operations, which shall be so located and conducted as to prevent any contamination of the milk or of cleaned equipment.

Item 9r. Milk house or room, cleanliness and flies. The floors, walls, ceilings, and equipment of the milk house or room shall be kept clean atall times. All means necessary for the elimination of flies shall be used.

Item 10r. Toilet. Every dairy farm shall be provided with one or more sanitary toilets conveniently located and properly constructed, operated and maintained, so that the waste is inaccessible to flies and does not pollute the surface soil or contaminate any water supply.

Item 11r. Water Supply. The water supply for the milk room and dairy barn shall be

* The number should be inserted when the ordinance is adopted. It should not exceed 5 years if the community wishes to be recognized as having adopted this ordinance.

properly located, constructed, and operated, and shall be easily accessible, adequate, and of a safe sanitary quality.

Item 12r. Utensils, construction. All multi-use containers or other utensils used in the handling, storage, or transportation of milk or milk products must be made of smooth nonabsorbent material and of such construction as to be easily cleaned, and must be in good repair. Joints and seams shall be soldered flush. Woven wire cloth shall not be used for straining milk. All milk pails shall be of a small-mouth design approved by the health officer. The manufacture, packing, transportation, and handling of single-service containers and container caps and covers shall be conducted in a sanitary manner.

Item 13r. Utensils, cleaning. All multi-use containers, equipment, and other utensils used in the handling, storage, or transportation of milk and milk products must be thoroughly cleaned after each usage.

Item 14r. Utensils, bactericidal treatment. All multi-use containers, equipment, and other utensils used in the handling, storage, or transportation of milk or milk products shall between each usage be subjected to an approved bactericidal process with steam, hot water, chlorine, or hot air.

Item 15r. Utensils, storage. All containers and other utensils used in the handling, storage, or transportation of milk or milk products shall be stored so as not to become contaminated before being used.

Item 16r. Utensils, handling. After bactericidal treatment no container or other milk or milk product utensil shall be handled in such manner as to permit any part of any person or his clothing to come in contact with any surface with which milk or milk products come in contact.

Item 17r. Milking, udders and teats, abnormal milk. The udders and teats of all milking cows shall be clean and rinsed with a bactericidal solution at the time of milking. Abnormal milk shall be kept out of the milk supply and shall be so handled and disposed of as to preclude the infection of the cows and the contamination of milk utensils.

Item 18r. Milking, flanks. The flanks, bellies, and tails of all milking cows shall be free from visible dirt at the time of milking.

Item 19r. Milkers' hands. Milkers' hands shall be clean, rinsed with a bactericidal solution, and dried with a clean towel immediately before milking and following any interruption in the milking operation. Wet-hand milking is prohibited. Convenient facilities shall be provided for the washing of milkers' hands.

Item 20r. Clean clothing. Milkers and milk handlers shall wear clean outer garments while milking or handling milk, milk products, containers, utensils or equipment.

Item 21r. Milk stools. Milk stools shall be kept clean.

Item 22r. Removal of Milk. Each pail of milk shall be removed immediately to the milk house or straining room. No milk shall be strained or poured in the dairy barn.

Item 23r. Cooling. Milk must be cooled immediately after completion of milking to 50°F. or less, and maintained at that average temperature, as defined in section 1 (S) until delivery. If milk is delivered to a milk plant or receiving station for pasteurization or separation, it must be delivered within 2 hours after completion of milking or cooled to 70°F. or less and maintained at that average temperature until delivered.

Item 24r. Bottling and capping. Milk and milk products shall be bottled from a container with a readily cleanable valve, or by means of an approved bottling machine. Bottles shall be capped by machine. Caps or cap stock shall be purchased in sanitary containers and kept therein in a clean dry place until used.

Item 25r. Personnel, health. The health officer or a physician authorized by him shall examine and take a careful morbidity history of every person connected with a retail raw dairy, or about to be employed, whose work brings him in contact with the production, handling, storage, or transportation of milk, milk products, containers, or equipment. If such examination of history suggests that such person may be a carrier of or infected with the organisms of typhoid or paratyphoid fever or any other communicable diseases likely to be transmitted through milk, he shall secure appropriate specimens of body discharges and cause them to be examined in a laboratory approved by him or by the State health authorities for such examinations and if the results justify such person shall be barred from such employment.

Such persons shall furnish such information, submit to such physical examinations, and submit such laboratory specimens as the health officer may require for the purpose of determining freedom from infection.

Item 26r. Miscellaneous. All vehicles used for the transportation of milk or milk products shall be so constructed and operated as to protect their contents from the sun and from contamination. All vehicles used for the transportation of milk or milk products in their final delivery containers shall be constructed with permanent tops and with permanent or roll-down sides and back, provided that openings of the size necessary to pass the delivery man may be permitted in the sides or back for loading and unloading purposes. All vehicles shall be kept clean and no substance capable of contaminating milk or milk products shall be transported with milk or milk

products in such manner as to permit contamination. All vehicles used for the distribution of milk or milk products shall have the name of the distributor prominently displayed. The immediate surroundings of the dairy shall be kept in a neat, clean condition.

Grade B raw milk. Grade B raw milk is raw milk which violates the bacterial standard and/or the abortion testing requirement for grade A raw milk, but which conforms with all other requirements for grade A raw milk, and has an average bacterial plate count not exceeding 1,000,000 per cubic centimeter, or an average direct microscopic count not exceeding 1,000,000 per cubic centimeter if clumps are counted, or 4,000,000 per cubic centimeter if individual organisms are counted, or an average reduction time of not less than 3½ hours, as determined under sections 1 (S) and 6.

Grade C raw milk. Grade C raw milk is raw milk which violates any of the requirements for grade B raw milk.

Certified milk-pasteurized. Certified milk-pasteurized is certified milk-raw which has been pasteurized, cooled, and bottled in a milk plant conforming with the requirements for grade A pasteurized milk.

Grade A pasteurized milk. Grade A pasteurized milk is grade A raw milk, with such exceptions as are indicated if the milk is to be pasteurized, which has been pasteurized, cooled, and bottled in a milk plant conforming with all of the following items of sanitation and the average bacterial plate count of which at no time after pasteurization and until delivery exceeds 30,000 per cubic centimeter, as determined under sections 1 (S) and 6.

The grading of a pasteurized milk supply shall include the inspection of receiving and collecting stations with respect to items 1p to 15p, inclusive, and 17p, 19p, 22p, and 23p, except that the partitioning requirement of item 5p shall not apply.

Item 1p. Floors. The floors of all rooms in which milk or milk products are handled or stored or in which milk utensils are washed shall be constructed of concrete or other impervious and easily cleaned material and shall be smooth, properly drained, provided with trapped drains, and kept clean.

Item 2p. Walls and ceilings. Walls and ceilings of rooms in which milk or milk products are handled or stored or in which milk utensils are washed shall have a smooth, washable, light-colored surface and shall be kept clean.

Item 3p. Doors and windows. Unless other effective means are provided to prevent the access of flies, all openings into the outer air shall be effectively screened and doors shall be of self-closing.

Item 4p. Lighting and ventilation. All rooms shall be well lighted and ventilated.

Item 5p. Miscellaneous protection from contamination. The various milk-plant operations shall be so located and conducted as to prevent any contamination of the milk or of the cleaned equipment. All means necessary for the elimination of flies shall be used. There shall be separate rooms for (a) the pasteurizing, processing, cooling, and bottling operations, and (b) the washing and bactericidal treatment of containers. Cans of raw milk shall not be unloaded directly into the pasteurizing room. Pasteurized milk or milk products shall not be permitted to come in contact with equipment with which unpasteurized milk or milk products have been in contact, unless such equipment has first been thoroughly cleaned and subjected to bactericidal treatment. Rooms in which milk, milk products, cleaned utensils, or containers are handled or stored shall not open directly into any stable or living quarters. The pasteurization plant shall be used for no other purposes than the processing of milk and milk products and the operations incident thereto, except as may be approved by the health officer.

Item 6p. Toilet facilities. Every milk plant shall be provided with toilet facilities conforming with the ordinances of the city of . . . . Toilet rooms shall not open directly into any room in which milk, milk products, equipment, or containers are handled or stored. The doors of all toilet rooms shall be self-closing. Toilet rooms shall be kept in a clean condition, in good repair, and well ventilated. In case privies or earth closets are permitted and used, they shall be separate from the building, and shall be of a sanitary type constructed and operated in conformity with the requirements of item 10r, grade A raw milk.

Item 7 p. Water supply. The water supply shall be easily accessible, adequate, and of a safe, sanitary quality.

Item 8p. Hand-washing facilities. Convenient hand-washing facilities shall be provided, including warm running water, soap, and approved sanitary towels. The use of a common towel is prohibited.

Item 9p. Sanitary piping. All piping used to conduct milk or milk products shall be "sanitary milk piping" of a type which can be easily cleaned with a brush. Pasteurized milk and milk products shall be conducted from one piece of equipment to another only through sanitary milk piping.

Item 10p. Construction and repair of containers and equipment. All multi-use containers and equipment with which milk or milk products come in contact shall be constructed in such manner as to be easily cleaned and shall be kept in good repair.

The manufacture, packing, transportation, and handling of single-service containers and container caps and covers shall be conducted in a sanitary manner.

Item 11p. Disposal of wastes. All wastes shall be properly disposed of.

Item 12p. Cleaning and bactericidal treatment of containers and equipment. All milk and milk products containers and equipment, except single-service containers shall be thoroughly cleaned after each usage. All containers shall be subjected to an approved bactericidal process after each cleaning and all equipment immediately before each usage. When empty and before being returned to a producer by a milk plant each container shall be effectively cleaned and subjected to bactericidal treatment.

Item 13p. Storage of containers and equipment. After bactericidal treatment all bottles, cans, and other multi-use milk or milk products containers and equipment shall be stored in such manner as to be protected from contamination.

Item 14p. Handling of containers and equipment. Between bactericidal treatment and usage, and during usage, containers and equipment shall not be handled or operated in such manner as to permit contamination of the milk.

Item 15p. Storage of caps, parchment paper, and single-service containers. Milk bottle caps or cap stock, parchment paper for milk cans and single-service containers shall be purchased and stored only in sanitary tubes and cartons, respectively, and shall be kept therein in a clean dry place.

Item 16p. Pasteurization. Pasteurization shall be performed as described in section 1 (L) of this ordinance.

Item 17p. Cooling. All milk and milk products received for pasteurization shall immediately be cooled in approved equipment to 50° F. or less and maintained at that temperature until pasteurized, unless they are to be pasteurized within 2 hours after receipt; and all pasteurized milk and milk products shall be immediately cooled in approved equipment to an average temperature of 50°F. or less, as defined in section 1 (S), and maintained thereat until delivery.

Item 18p. Bottling. Bottling of milk and milk products shall be done at the place of pasteurization in approved mechanical equipment.

Item 19p. Overflow milk. Overflow milk or milk products shall not be sold for human consumption.

Item 20p. Capping. Capping of milk and milk products shall be done by approved mechanical equipment. Hand capping is prohibited. The cap or cover shall cover the pouring lip to at least its largest diameter.

Item 21p. Personnel, health. The health officer or a physician authorized by him shall examine and take a careful morbidity history of every person connected with a pasteurization plant, or about to be employed, whose work brings him in contact with the production, handling, storage, or transportation of milk, milk products, containers, or equipment. If such examination or history suggests that such person may be a carrier of or infected with the organisms of typhoid or paratyphoid fever or any other communicable diseases likely to be transmitted through milk, he shall secure appropriate specimens of body discharges and cause them to be examined in a laboratory approved by him or by the State health authorities for such examinations, and if the results justify such person shall be barred from such employment. Such persons shall furnish such information, submit to such physical examinations, and submit such laboratory specimens as the health officer may require for the purpose of determining freedom from infection.

Item 22p. Personnel, cleanliness. All persons coming in contact with milk, milk products, containers, or equipment shall wear clean outer garments and shall keep their hands clean at all times while thus engaged.

Item 23p. Miscellaneous. All vehicles used for the transportation of milk or milk products shall be so constructed and operated as to protect their contents from the sun and from contamination. All vehicles used for the transportation of milk or milk products in their final delivery containers shall be constructed with permanent tops and with permanent or roll-down sides and back, provided that openings of the size necessary to pass the delivery man may be permitted in the sides or back for loading and unloading purposes. All vehicles shall be kept clean, and no substance capable of contaminating milk or milk products shall be transported with milk or milk products in such manner as to permit contamination. All vehicles used for the distribution of milk or milk products shall have the name of the distributor prominently displayed. The immediate surroundings of the milk plant shall be kept in a neat, clean condition.

Grade B pasteurized milk. Grade B pasteurized milk is pasteurized milk which violates the bacterial standard for grade A pasteurized milk and/or the provision of lip-cover caps of item 20p and/or the requirement that grade A raw milk be used, but which conforms with all other requirements for grade A pasteurized milk, has been made from raw milk of not less than grade B quality, and has an average bacterial plate count after pasteurization and before delivery not exceeding 50,000 per cubic centimeter, as determined under sections 1 (S) and 6.

Grade C pasteurized milk. Grade C pasteurized milk is pasteurized milk which violates

any of the requirements for grade B pasteurized milk.

Section 8. Grades of milk and milk products which may be sold. From and after 12 months from the date on which this ordinance takes effect no milk or milk products shall be sold to the final consumer or to restaurants, soda fountains, grocery stores, or similar establishments except . . .: Provided, that when any milk distributor fails to qualify for one of the above grades the health officer is authorized to revoke his permit, or in lieu thereof to degrade his product and permit its sale during a temporary period not exceeding 30 days or in emergencies such longer period as he may deem necessary.

Section 9. Supplementary grading prescribed and regrading authorized. If at any time between the regular announcements of the grades of milk or milk products, a lower grade shall become justified, in accordance with sections 5,6, and 7 of this ordinance, the health officer shall immediately lower the grade of such milk or milk products, and shall enforce proper labeling and placarding thereof.
Any producer or distributor of milk or milk products the grade of which has been lowered by the health officer, and who is properly labeling his milk and milk products, may at any time make application for the regrading of his product.
Upon receipt of a satisfactory application, in case the lowered grade is the result of an excessive average bacterial plate count, direct microscopic count, reduction time, or cooling temperature, the health officer shall take further samples of the applicant's output, at a rate of not more than two samples per week. The health officer shall regrade the milk or milk products upward whenever the average of the last four sample results indicates the necessary quality, but not before the lapse of 2 weeks from the date of degrading.
In case the lowered grade of the applicant's product is due to a violation of an item of the specifications prescribed in section 7, other than average bacterial plate count, direct microscopic count, reduction time,or cooling temperature, the said application must be accompanied by a statement signed by the applicant to the effect that the violated item of the specifications has been conformed with. Within 1 week of the receipt of such an application and statement the health officer shall make a reinspection of the applicant's establishment, and thereafter as many additional reinspections as he may deem necessary to assure himself that the applicant is again complying with the higher grade requirements, and, in case the findings justify, shall regrade the milk or milk products upward, but not before the lapse of 2 weeks from the date of degrading.

Section 10. Transferring or dipping milk; delivery containers; handling of more than one grade; delivery of milk at quarantined residences. Except as permitted in this section, no milk producer or distributor shall transfer milk or milk products from one container to another on the street, or in any vehicle or store, or in any place except a bottling or milk room especially used for that purpose. The sale of dip milk is hereby prohibited.
All pasteurized milk and milk products shall be placed in their final delivery containers in the plant in which they are pasteurized, and all raw milk and milk products sold for consumption in the raw state shall be placed in their final delivery containers at the farm at which they are produced. Milk and milk products sold in the distributor's containers in quantities less than 1 gallon shall be delivered in standard milk bottles or in single-service containers. It shall be unlawful for hotels, soda fountains, restaurants, groceries, and similar establishments to sell or serve any milk or milk product except in the original container in which it was received from the distributor or from a bulk container equipped with an approved dispensing device: Provided, that this requirement shall not apply to cream consumed on the premises, which may be served from the original bottle or from a dispenser approved for such service.
It shall be unlawful for any hotel, soda fountain, restaurant, grocery or similar establishment to sell or serve any milk or milk products which have not been maintained while in its possession at a temperature of 50° F. or less.
No milk or milk products shall be permitted to come in contact with equipment with which a lower grade of milk or milk products has been in contact unless such equipment has first been thoroughly cleaned and subjected to bactericidal treatment.
Bottled milk or milk products, if stored in water, shall be so stored that the tops of the bottles will not be submerged.
It shall be the duty of all persons to whom milk or milk products are delivered to clean thoroughly the containers in which such milk or milk products are delivered before returning such containers. Apparatus, containers, equipment, and utensils used in the handling, storage, processing, or transporting of milk or milk products shall not be used for any other purpose without the permission of the health officer. The delivery of milk or milk products to and the collection of milk or milk products

containers from residences in which cases of communicable disease transmissible through milk supplies exist shall be subject to the special requirements of the health officer.

Section 11. Milk and milk products from points beyond the limits of routine inspection. Milk and milk products from points beyond the limits of routine inspection of the city of . . . . may not be sold in the city of . . . ., or its police jurisdiction, unless produced and/or pasteurized under provisions equivalent to the requirements of this ordinance: Provided, that the health officer shall satisfy himself that the health officer having jurisdiction over the production and processing is properly enforcing such provisions.

Section 12. Future dairies and milk plants. All dairies and milk plants from which milk or milk products are supplied to the city of . . . . which are hereafter constructed, reconstructed, or extensively altered shall conform in their construction to the requirements of this ordinance for grade A dairy farms producing milk for consumption in the raw state, or for grade A pasteurization plants, respectively: Provided, that the requirements of a two-room milk house shall be waived in the case of dairies the milk from which is to be pasteurized. Properly prepared plans for all dairies and milk plants which are hereafter constructed, reconstructed, or extensively altered shall be submitted to the health officer for approval before work is begun. In the case of milk plants signed approval shall be obtained from the health officer and/or the State health department.

Section 13. Notification of disease. Notice shall be sent to the health officer immediately by any producer or distributor of milk or milk products upon whose dairy farm or in whose milk plant any infectious, contagious, or communicable disease occurs.

Section 14. Procedure when infection suspected. When suspicion arises as to the possibility of transmission of infection from any person concerned with the handling of milk or milk products, the health officer is authorized to require any or all of the following measures: (1) The immediate exclusion of that person from milk handling (2) the immediate exclusion of the milk supply concerned from distribution and use, (3) adequate medical and bacteriological examination of the person, of his associates, and of his and their body discharges.

Section 15. Enforcement interpretation. This ordinance shall be enforced by the health officer in accordance with the interpretations thereof contained in the 1939 edition of the United States Public Health Service Milk Code, a certified copy of which shall be on file in the city clerk's office.

Section 16. Penalty. Any person who shall violate any provision of this ordinance shall be fined not more than . . . at the discretion of the court. Each and every violation of the provisions of this ordinance shall constitute a separate offense.

Section 17. Repeal and date of effect. All ordinances and parts of ordinances in conflict with this ordinances are hereby repealed; and this ordinance shall be in full force and effect immediately upon its adoption and its publication, as provided by law.

Section 18. Unconstitutional clause. Should any section, paragraph, sentence, clause, or phrase of this ordinance be declared unconstitutional or invalid for any reason, the remainder of said ordinance shall not be affected thereby.

References:
1. Preventive Medicine and Hygiene - Rosenau
2. Encyclopedia Britannica
3. U.S.P.H.S. - Standard Milk Ordinance
4. Louisiana Milk Code
5. Dairy Science - Peterson
6. Methods and Standards for Production of Certified Milk
7. Standard Methods - American Public Health Association

J. DETECTING ADULTERATED MILK USING A QUEVENNE LACTOMETER

The lactometer is an instrument used to assist in detecting whether milk has been watered, skimmed, or both. The instrument is standardized to such a weight that when placed in normal milk it will sink to the mark 32, which means that the milk has a specific gravity of 1.032. Similarly, if the milk has a specific gravity of 1.015 or 1.040 the lactometer will sink to the marks 15 and 40, respectively. From this it will be seen that the method of obtaining the specific gravity of milk from the lactometer reading, is to divide the reading by 1,000 and add 1.0. Conversely, the lactometer reading can be determined from the specific gravity of milk by subtracting and multiplying by 1,000. Specific gravity of normal milk is from 1.029 to 1.034.

Correcting the Lactometer Reading: All lactometers are standardized for use at a certain temperature, viz 60 degrees F. For each degree above 60 degrees F. add .1 to the lactometer reading. Example: Lactometer reading is 32 at 66 degrees F. or 32.6, and the specific gravity of the milk is 1.0326. For each degree below 60 degrees F. subtract .1 from the lactometer reading.

Calculating the Percent of Solids not Fat and Total Solids:

Figuring the percentage of solids not fat.

Formula: Lactometer Reading + (.2 x Fat Test in %) = % M.S.M.F.

Example: In 4% Butter Fat milk with lactometer reading 26.4, what is the % of milk solids not fat (M.S.N.F.) ?

$$\frac{26.4}{4} + (.2 \times 4\%) = 6.6 + .8 = 7.14\% \text{ Milk Solids Not Fat}$$

For Total Solids add the butterfat percentage to Milk Solids not fat, Thus:

7.14% + 4% = 11.14% Total Milk Solids

To find the Percentage of Water added use the following formula:

$$\frac{\underset{\text{(State Standard)}}{\%\ \text{M.S.N.F.}} - \underset{\text{(Obtained)}}{\%\ \text{M.S.N.F.}}}{\text{Standard}\ \%\ \text{M.S.N.F.}} \times 100 = \%\ \text{Water added.}$$

Example:

$$\frac{8.5 - 7.14}{8.5} \times 100 = \frac{1.36}{8.5} \times 100 = 16\% \text{ Water added.}$$

Added water should be confirmed by a freezing point determination. In sending samples to the main laboratory, the greatest care should be taken to add the CORRECT amount of formalin to the sample. Too little will <u>not</u> preserve the milk; too much will <u>vitiate</u> the freezing point determination.

The Laboratory Report

When milk is sent to the laboratory for complete analysis, the following data is usually recorded on the report returned from the laboratory:

	Standard in Louisiana
1. Number of the Sample	
2. Name of Dairy	
3. Type of Milk (Pasteurized or Raw)	
4. The Percent Butter Fat	3 1/4% or more
5. Temperature of Milk when brought to Laboratory	50° F. or less
6. Lactometer Reading	
7. Corrected Lactometer Reading	32 or more at 60° F.
8. Percent Solids not Fats	8 1/2% or more
9. Phosphatase Test Reading	2 Scharer Units or less
10. Plate Count	Depends on grade of milk

In order to correctly appraise the above data it is necessary to know what the readings should be for "Standard" and safe milk.

The percent butterfat is adequate depending upon the requirements of the ordinance in the particular locality. The Louisiana Milk Code and the United States Public Health Service Standard Milk Ordinance requires a minimum of 3 1/4% butterfat to be present in milk.

In order to be fair to the dairy, the milk when brought to the laboratory should be 50° F. or less. Since at higher temperatures the bacteria may grow too fast to show the correct bacterial quality of the milk when it was picked up. The milk should also be 50°F. or less when picked up from the distributor in order to conform with the law.

The lactometer reading is an indication of specific gravity of the milk. The specific gravity reading is an indication of the amount of "body" or solids in the milk. The greater the specific gravity the more the solids in the milk. The specific gravity reading is sensitive

to temperature change. The higher the temperature the lower the specific gravity and vice versa. Therefore, the lactometer reading will depend upon the temperature of the milk at time of the reading. Since most samples of milk have more or less different temperatures when the lactometer readings are made, the readings of the various samples are not easily compared unless corrections can be made for a definite temperature. For this reason all lactometer readings are corrected for 60° F., and the reading which has been set by the Louisiana State Health Department as adequate at this temperature is 32° or more. A low lactometer reading is an indication that water has been added to the milk. All lactometer readings are corrected for this standard temperature.

Percent solids not fats are important to be determined, since milk of adequate quality has a certain percent of such solids, whereas a lowering of this percent may indicate the addition of water to the milk. The Louisiana Milk Code allows a minimum of 8½% solids not fats.

The phosphatase test should show a reading of 2 Scharer units or less in order for the pasteurization of the milk to be considered satisfactory.

The plate count will, of course, be adequate depending on whether the milk is being produced under the specifications of the Louisiana Milk Code, United States Public Health Service Standard Milk Ordinance, or any other ordinance.

K. SPECIFICATIONS, CARE AND MANAGEMENT OF PASTEURIZATION EQUIPMENT
(According to U.S.P.H.S. Standard Milk Code of 1939)

Specifications for pasteurizing indicating, recording, and test thermometers.
Public Health Reason. Unless the thermometer used on pasteurization equipment and those used for checking their accuracy are reasonably accurate, there can be no assurance that the proper pasteurization temperature is applied.
Satisfactory Compliance. All indicating and recording thermometers used in connection with the pasteurization of milk or milk products, and all test thermometers used by the health officer in checking plant thermometers shall comply with the following specifications. These specifications shall be complied with in the case of all new equipment and in the case of all replacements of indicating and recording thermometers. They shall also apply to all repairs of recording thermometers requiring a renewal of the tube system. The accuracy and lag specifications shall apply to old as well as new equipment.

Indicating Thermometers Located on Pasteurization Vats or Pockets.

Type. V shaped brass or equally noncorrodible scale case, with removable glass front, mercury actuated, line etched in glass tube at 143°F., filling above mercury, nitrogen, or equally suitable gas.
Magnification of Mercury Column. To apparent width of not less than 1/16 inch.
Scale Range. 130° to 210°F., extension either side permissive, protected against damage at 220° F.
Temperature Represented by Smallest Scale Division. Not more than 1°F. between 140° and 150°F.
Number of Degrees per Inch of Scale. Not more than 16.
Accuracy. Within 0.5°F., plus or minus, between 142°F. and 145°F.
Submerged Stem Fittings. Pressure-tight seat against inside wall of holder. No threads exposed to milk. Location of seat to conform to that of standard I.A.M.D. wall type fitting.

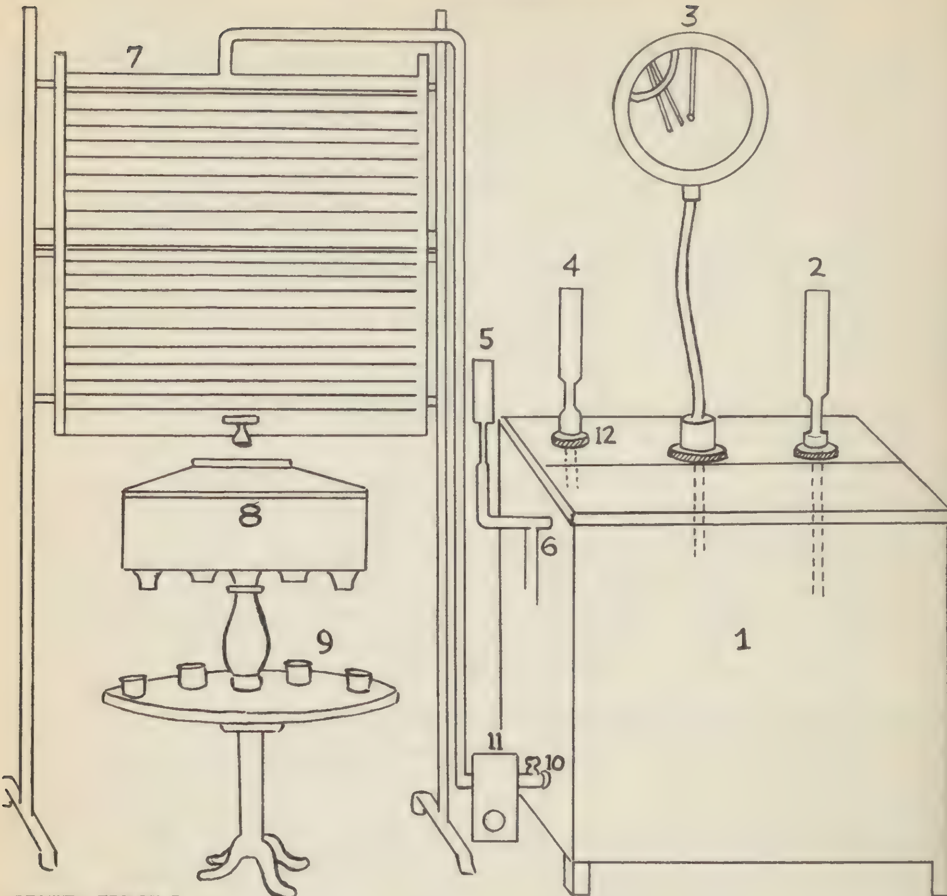
I.A.M.D. Stands for International Association of Milk Dealers.

Bulb. Corning normal, or equally suitable thermometric glass.

Indicating Thermometers Located on Pasteurization Pipe Lines.

Type. V shaped brass or equally noncorrodible scale case, with removable glass front, mercury actuated, lines etched on stem at 143°F. and at 160°F., filling above mercury, nitrogen, or equally suitable gas.

FIGURE I - PASTEURIZATION UNIT



LEGEND: FIGURE I

1. Pasteurizer.
2. Indicating Thermometer - its bulb is long and extends into the milk.
3. Recording Thermometer - its bulb is long and extends into the milk. To the bulb is attached a long chord so that the thermometer proper may be attached to a wall or post close to the pasteurizer.
4. Air-Heating Thermometer - its bulb is short and does not extend into the milk. It registers the temperature of the air above the milk.
5. Steam Line Thermometer - it registers the temperature of the steam which goes into the coils, surrounding the milk vat, which in turn heats the water surrounding the coils. The water then heats the milk in the vat which is surrounded by the coils and the water.
6. Steam Pipe line carries steam to coils surrounding milk vat.
7. Milk Cooler - milk trickles down cooled coils of the aerator and is collected in the bottler from which it is directed into milk bottles mechanically. The aerator should be protected by shields. The upper half of the aerator contains water in its coils, the lower half contains brine. This arrangement allows the gradual cooling of the milk and prevents the hot milk from freezing on the upper part of the aerator.
8. The Bottler - this receives the milk from the cooler for bottling.
9. Mechanical bottling device.
10. Milk outlet valve which allows pasteurized milk to be pumped onto the cooler from the pasteurizing vat.
11. Milk pump which pumps milk to the cooler.
12. Thermometer holder onto which fits the seat of the thermometer.

FIGURE 2 -- RECORDING THERMOMETER

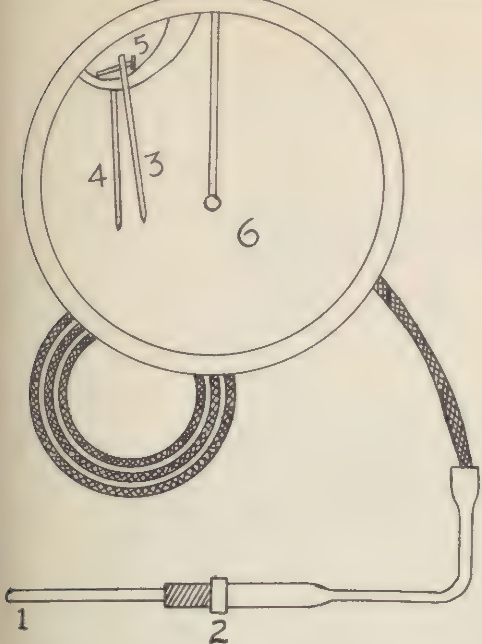
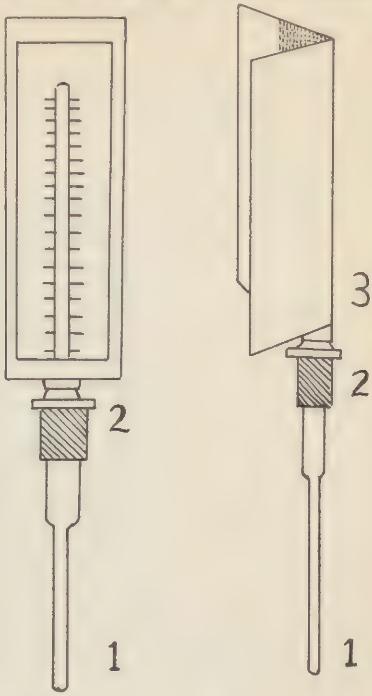


FIGURE 3 --STRAIGHT-STEM THERMOMETER FOR PASTEURIZATION PIPE LINE AND AIR AND FOAM TEMPERATURES



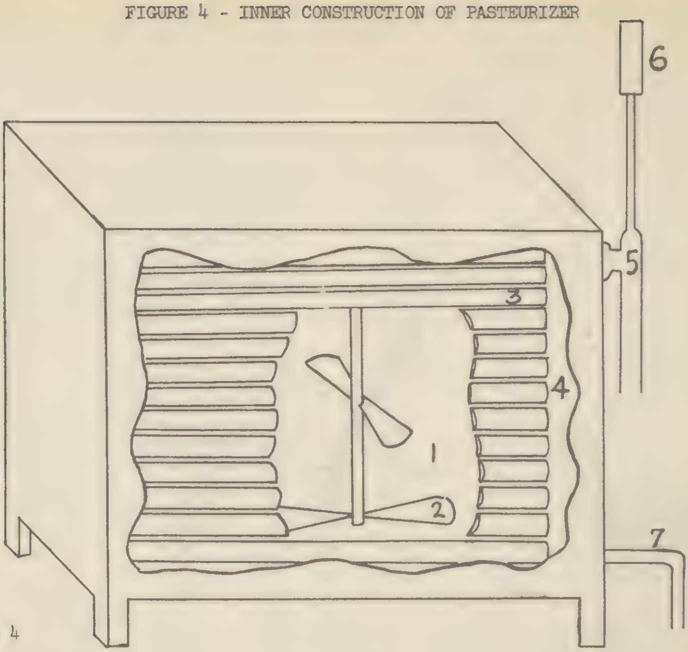
LEGEND: FIGURE 2

1. The Bulb - this is usually made of corning normal glass or its equivalent.
2. This is the seat of the thermometer which fits into a device on the pasteurizer called the holder.
3. The pen-arm is the pen-like device which vacillates according to the change of temperature affecting the bulb. As it vacillates and as the chart revolves, the continuous state of the temperature in the vat is recorded on the chart. This pen-arm is the temperature arm.
4. This is another pen-arm which registers on the chart paper the amount of milk flowing from the pasteurizing vat. This is the milk-flow recorder arm, and it is completely independent of the temperature arm and therefore the recording thermometer in Figure 2 should be shown with two outlets instead of one - one for the chord of the temperature mechanism, another for the chord of the milk-flow recorder mechanism. Not all recording thermometers have a milk-flow recorder device and therefore do not have two outlets.
5. Pen-Arm Setting Device - this is a set screw at the outer end of the pen-arm, used for adjusting the pen-arm to the temperature of the indicating thermometer. The indicating thermometer, thus, is the check for the recording thermometer.
6. Recorder Chart Paper - this chart paper is ruled to form a circular graph. The concentric circular rulings indicate the degrees of temperature. The spoke-like lines measure the time in terms of hours and minutes. If the recording thermometer also has a milk-flow recording device, then the concentric circular rulings also indicate the quantity of milk flowing from the pasteurizer. As the chart revolves at the same rate as the hour hand on a clock, the pen arms register the temperature of the milk in the pasteurizing vat, and the quantity of milk flowing from the pasteurizer (i.e. quantity of pasteurized milk) during the day's operation. The spoke-like lines or any part of one of them is called a chord.

LEGEND: FIGURE 3

1. The Bulb - this is made of corning normal glass or its equivalent. The bulb is short or long depending where the thermometer is to be used. For example, air and foam temperature thermometers have shorter bulbs, than indicating thermometers, since each demands a length according to its function and according to the construction of the pasteurizer.
2. The Seat - this fits onto the holder fitting of the pasteurizer. The thread is so made that it does not possibly come into contact with the milk.
3. This is a side view of a v-shaped thermometer.

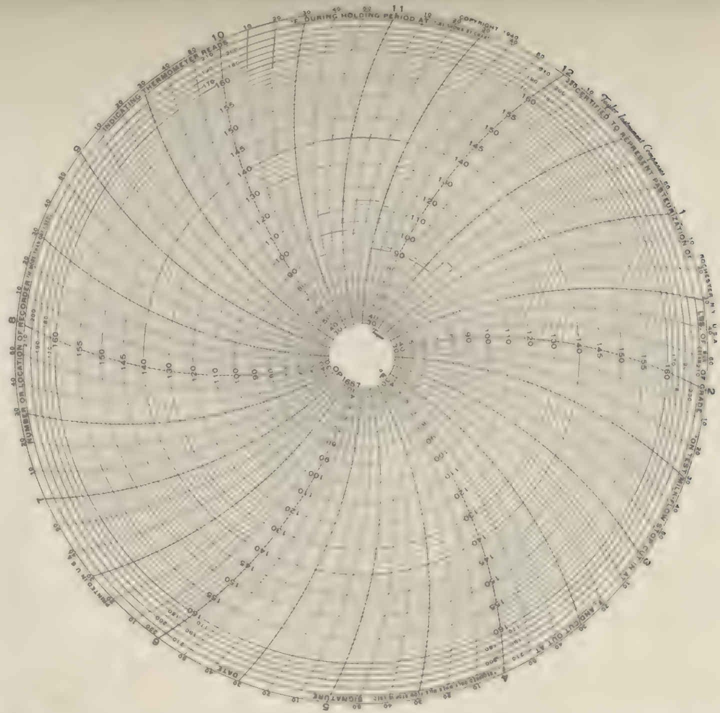
FIGURE 4 - INNER CONSTRUCTION OF PASTEURIZER



LEGEND: FIGURE 4

1. The vat which contains the milk to be pasteurized.
2. The agitator, which keeps the milk circulated so that the temperature is kept equalized throughout the vat to keep cream well circulated.
3. Coils surrounding the vat. Steam is passed through the coils to heat the water surrounding the vat.
4. Space between coils and outer wall of pasteurizing which contains the water that is heate to the desired temperature by the coils. The heated water is controlled so that it trans mits enough heat to the milk in the vat to pasteurize it.
5. Steam-inlet, which provides the steam for heating the coils.
6. Steam-line thermometer.
7. Steam-outlet from coils.

MAGNIFICATION OF MERCURY COLUMN - To apparent width of not less than 1/16 inch.
SCALE RANGE - 138° to 165° F., with extension on either side permissive, protected against damage at 220° F.
TEMPERATURE REPRESENTED BY SMALLEST SCALE DIVISION - 0.5° F. between 138° and 165° F.
NUMBER OF DEGREES PER INCH OF SCALE - not more than 8.
ACCURACY - Within 0.5° F., plus or minus, throughout specified scale range.
STEM FITTINGS - Pressure-tight seat against inside wall of fittings; no threads exposed to milk; distance from under side of ferrule to top of bulb not less than 2 inches.
THERMOMETRIC LAG - When thermometer is at room temperature and then immersed in a well-stir water bath maintained at a temperature at which the thermometer to be tested reads 160° F., the time required for the reading to increase from 141°F. to 153°F. shall not be more than 4 seconds. This time interval is the thermometric lag.
BULB - Corning normal, or equally suitable thermometric glass.
The local or State inspector shall once each month check the accuracy of all indicating thermometers at the legally required temperature of pasteurization by means of a standardiz thermometer reading within 0.2° F. In the case of indicating thermometers located on vats or pockets, this may be done by lowering a standardized maximum self-registering test thermometer to the position of the bulb of the indicating thermometer in the holder during the holding period with the milk in agitation. In the case of indicating thermometers located on pipe lines this may be done by fitting the indicating thermometer to a sanitary cross an inserting a standardized test thermometer through a thermometer holder (I.A.M.D. fitting No 55-A) equipped with a rubber washer for holding the thermometer in place against pressure in the milk line, and attached to one of the arms of the cross by means of a union nut(I.A. M.D. fitting No. 13). The inspector should carry with him thermometer holders of the sizes necessary for the plants in his territory. Ordinarily the 1 ½ inch and 2 inch sizes will be sufficient. The inspector shall identify by number, seal, or otherwise the indicating ther mometer when tested.



CASE - Moisture Proof (under operating conditions obtained in pasteurization plants).
SCALE RANGE - 130° to 150°F., or, in the case of 15-second pasteurization, 150° to 200° F., with extension of scale on either side permissive.
TEMPERATURE REPRESENTED BY SMALLEST TEMPERATURE-SCALE DIVISION - 1°F. between 140° and 145°F.,or, in the case of 15-second pasteurization, between 157° and 162°F.
LENGTH OF 1°F. SCALE DIVISION - Not less than one-sixteenth inch between 142° and 145°F., or, in the case of 15 second pasteurization, between 159° and 162°F.
TIME REPRESENTED BY SMALLEST TIME-SCALE DIVISION ON RECORDING CHART-Not more than 10 minutes.

Chord or Straight-Line Length of 10 minute Scale Division. Not less than one-fourth inch between 142° and 145° F., or, in the case of 15-second pasteurization, between 159° and 162° F.

Time Accuracy. The recorded elapsed time as indicated by the chart rotation shall not exceed the true elapsed time as shown by a correct watch over a period of at least 30 minutes. Electric clocks, if used, shall have a spring reserve which will continue the clock in opera- tion for a period of at least one hour during current failure.

Temperature Accuracy. Within 1°F., plus or minus, between 142° and 145° F., or, in the case of 15-second pasteurization, between 159° and 162° F. The accuracy may be determined by the following mode of procedure:

1. The instrument shall be adjusted to read correctly (if necessary) at some point between 142° and 145° F., or, in the case of 15-second pasteurization, between 159° and 162°F., while it is connected with the pasteurization apparatus, and as shown by the tested indicating thermometer after a stabilization period of 5 minutes at constant temperature with the agitation device in operation.
2. The bulb shall be removed from the pasteurizer and immersed for not less than 5 minut in boiling water.
3. The bulb shall then be immersed for not less than 5 minutes in melting ice.
4. The bulb shall be again connected with pasteurizer and temperature brought to a point between 142° and 145° F., or, in the case of 15-second pasteurization, between 159° an 162°F., as shown by the tested indicating thermometer under the same test conditions outlined under No. (1). At this time the deviation of the recording thermometer reading from that of the indicating thermometer shall not be more than 1° F., plus or minu

Frequency of Accuracy Tests. The temperature accuracy of the recording thermometer shall be tested by the health officer upon installation and at least semiannually thereafter and at such other times as the operator's daily check with the indicating thermometer shows the recording thermometer to be frequently incorrect. The time accuracy of the recorder shall be tested monthly by the health officer.

Pen-Arm Setting Device. Easily accessible, simple to adjust.

Pen and Chart Paper. Designed to give line not over one-fortieth inch thick when in proper adjustment, which shall be easy to maintain.

Pressure System (Bulb, Tube, Spring, etc.). Protected against damage at bulb temperature of 220° F.

Stem Fitting. Pressure-tight seat against inside wall of holder or pipe. No threads expose to milk. Location of seat in batch-type pasteurizers to conform to that of a standard I.A. M.D. wall-type fitting.

Chart Speed. The chart shall make one revolution in 12 hours, and shall be graduated for a 12-hour record. The rotating chart support shall be provided with a pin to puncture the chart in a manner to prevent its fraudulent rotation.

Record of Milk Flow. On installations equipped with a milk-flow stop the recording thermom- eter located nearest the milk-flow stop shall be provided with an additional pen arm for recording upon the chart the full record of the time during which the milk-flow stop is preventing the flow of milk into the holder.

INSPECTORS' MAXIMUM SELF-REGISTERING THERMOMETERS TO BE USED IN THE TESTING OF INDICATING THERMOMETERS ON PASTEURIZATION VATS OR POCKETS

A self-registering thermometer is one in which the mercury does not go down after it has risen unless it is shaked down. Thus the thermometer will register the highest temperature to which the medium has been heated and maintain its mark for any length of time.

Type. Maximum self-registering, mercury-actuated, pocket type, readily cleanable.

Magnification of Mercury Column. To apparent width of not less than one-sixteenth inch.

Protection Against High-Temperature Damage. At 155°F.

Scale Range. 1[illegible]° to 148°F., with extension of scale on either side permissive, 1[illegible]° point to be not less than three-fourths inch above contraction.

Temperature Represented by Smallest Scale Division. 0.2°F.
Number of Degrees Per Inch of Scale - Not more than 6.
Accuracy. Within 0.2°F., plus or minus, between 142° and 145°F. The accuracy shall be checked against a thermometer which has been tested by the United States Bureau of Standards.
Case. Metal, provided with suspension ring and fountain-pen clip.
Armor. Thermometers, if armored, to be easily removable for cleaning, armor to be fenestrated opposite thermometer bulb; scale to be visible without removing armor.
Bulb. Corning normal, or equally suitable thermometric glass.
The inspector should check maximum self-registering test thermometer against themselves occasionally for failure to hold reading when taken from the liquid in which they have been immersed. This may be done by holding them in clear water at approximately 142° F., reading the temperature while immersed, and then reading the temperature again after the thermometer has been removed from the water.

INSPECTORS' THERMOMETERS TO BE USED IN THE TESTING OF INDICATING THERMOMETERS LOCATED ON PASTEURIZATION PIPE LINES

Type. Mercury actuated, readily cleanable, plain front, enameled back, top finish with glass ring, length 12 inches, standardized for 4-inch immersion, immersion point to be etched on stem; contraction chamber to be of narrow type immediately above bulb, not over 1 inch long, mercury to stand in contraction chamber at 32° F.
Protection Against High-Temperature Damage. At 220°F.
Scale Range. 138° to 165° F. with extension of scale on either side permissive, 138° point to be not less than 1 inch above immersion line.
Temperature Represented by Smallest Scale Division. 0.2° F.
Number of Degrees Per Inch of Scale. Not more than 6.
Accuracy. Within 0.2°F., plus or minus, throughout specified scale range. The accuracy shall be checked against a thermometer which has been tested by the United States Bureau of Standards.
Carrying Case. Felt-lined metal.
Bulb. Corning normal, or equally suitable thermometric glass.

SPECIFICATIONS TO INSURE THAT THE REQUIRED PASTEURIZATION TEMPERATURE AND TIME WILL BE APPLIED TO EVERY PARTICLE OF MILK AND MILK PRODUCTS

Public Health Reason. Recording thermometers are the only means available for furnishing the health officer with a record of the time and temperature of pasteurization. Experience has shown that recording thermometers, due to their mechanical complexity, are not entirely reliable. Therefore, mercury indicating thermometers, which are much more reliable, are necessary to check the recording thermometers and to assure that proper temperatures are applied. The recording thermometer shows the temperature of the milk immediately surrounding its bulb, and shows the holding time in certain designs, but cannot indicate the temperature of the milk in other portions of the holder, nor the holding time in certain other types of equipment. The pasteurizer must therefore be so designed and operated and, where necessary, provided with automatic controls to insure that every portion of the milk will be subjected to the proper temperature for the required length of time.
Satisfactory Compliance. The following specifications shall be satisfied for the respective types of pasteurization equipment.

REQUIREMENTS FOR SYSTEMS IN WHICH THE MILK OR MILK PRODUCTS ARE BROUGHT TO THE FINAL PASTEURIZATION TEMPERATURE AFTER ENTERING THE HOLDER

Temperature Control

1. Limitation of Simultaneous Temperature Differences. The holder shall be so designed that the simultaneous temperature difference between the milk at the center of the holder vat and the coldest milk in the vat will not exceed 1°F. at any time during the holding period. This requirement may be assumed to have been satisfied if the holder is provided with adequate agitation operating throughout the holding period. By "adequate agitation" is meantagitation so designed as to sweep the milk currents effectively through all zones occupied by the milk, including the outlet port, but excluding inlet or outlet pipes surrounded by milk in the process of pasteurization and open to the holder at the bottom.
2. Location and Required Readings of Indicating and Recording Thermometers. Each such holder shall be equipped with both an indicating and a recording thermometer, provided that thermometer equipment may be transferred from one holder to another if the required thermometer equipment is in place on each holder during the entire filling, heating , holding, and emptying periods. Said thermometers shall read for each batch at least the required pasteurization temperature through the required holding period. The temperature shown by the recording thermometer shall be checked daily

by the plant operator against the temperature shown by the indicating thermometer and at least monthly by the health officer, and the readings recorded on the instrument chart. The recording thermometer shall be kept adjusted so as at no time to read higher than the indicating thermometer. No batch of milk or milk products shall be pasteurized unless it is sufficient in volume to cover the bulbs of the indicating and recording thermometer.

Time Control

3. Insurance of Minimum Holding Period. Holders ahll be so operated that the record charts will indicate at least 143°F. for a period of not less than the following: (a) If cooling is begun in the holder simultaneously with, or before, the opening of the outlet valve, 30 minutes. (b) If cooling is either begun in the holder after the opening of the outlet valve or is done entirely outside of the holder, 30 minutes plus the emptying time to the level of the recording thermometer bulb. The emptying time shall be determined by the health officer for each holder so operated. No milk shall be added to the holder after the start of the holding period.

Record of Temperature and Time

4. Recording Thermometer Charts. All recording thermometer charts shall be preserved for a period of 3 months for the information of the health officer. No chart shall be used more than one day except with the permission of the health officer. All charts shall contain the following information: (a) Date. (b) Number or location of the recorder, if more than one is used. (c) Reading of indicating thermometer at some indicated time during the holding period. Monthly, initials of health officer opposite reading. (d) Monthly, the time accuracy of the recorder, as found by official test. (e) Amount and grade of pasteurized milk or milk products represented by chart. (f) Record of unusual occurrences. (g) Signature or initials of operator.

These chart entries may be conveniently made if each plant provides itself with a rubber stamp containing the above items with blank spaces for entries. A suggested stamp is shown below.

Date . . . .(Identity of pasteurization Pla
Number of Location of Recorder . . . .
Reading of Indicating Thermometer . . . . at . . . . o'clock
*Indicating thermometer reading when milk-flow stop cut in . . . . °F;
cut out . . . . °F.
Product . . . . .Grade . . . . Gals. . . . .
No unusual occurence, except as noted on reverse side
Signature or initials of operator . . . .
* This item to be included only if milk-flow stop is used.

REQUIREMENTS FOR SYSTEMS IN WHICH THE MILK OR MILK PRODUCTS ARE BROUGHT TO THE FINAL PASTEURIZATION TEMPERATURE BEFORE ENTERING THE HOLDER

Temperature Control

1. Thermostatic Control. Each such system shall be equipped with a dependable thermostatic control so designed and set as to cause every particle of milk and milk products to be heated automatically to at least the required pasteurization temperature.
2. Milk-Flow Stop Required. Automatic milk-flow stops are devices which stop the forward flow of milk whenever its temperature drops below the required limit in case the thermostat or the heat source fails. Such devices include automatic milk-pump stops (which automatically start and stop the milk-pump motors at the required temperature) and automatic flow-diversion devices (which automatically divert the milk away from all downstream points whenever it drops below the required temperature, and automatically resume forward flow when it again reaches the required temperature). Each system in which the milk or milk products are brought to the final pasteurization temperature before they enter the holder shall be equipped with an automatic milk-flow stop which complies with the following specifications:
3. Milk-flow Stop Specifications. The design and temperature setting of milk-flow stops shall be such that the flow of milk will, during descending temperatures, completely stop or be diverted before or when the indicating thermometer reaches the pasteurization temperature, and will not, during ascending temperatures, resume forward flow before the pasteurization temperature is again reached. Milk-flow stops are intended as safety devices and not as a part of the routine temperature control equipment. The routine operating milk temperature shall therefore be sufficiently above the temperature setting of the milk-flow stop so that the latter will not be brought into

frequent operation. The stop shall be so designed that the plant operator cannot lower the temperature setting without the knowledge of the health officer. This may be done by means of seals, which shall not be broken by the plant operator without promptly notifying the health officer.

The control mechanism of all flow-stops shall be so designed that the forward flow of milk cannot start unless the temperature of the stop-bulb is at or above the cut-in setting. Manual switches for starting milk pumps are prohibited where milk-pump stops are used, but not where flow-diversion devices are used. The system shall be so designed that no milk can be bypassed around the flow-stop bulb, which shall not be removed from its proper position during the pasteurization process. All new automatic milk-flow stops shall be combined with a recording thermometer actuated by the same bulb system, as otherwise it is impossible to determine satisfactorily the thermometric lag of the recorder-controller; but the cut-out response shall be independent of the temperature pen-arm response, as by means of separate elements actuated by the same bulb system,so that if the friction lag of the pen arm increases beyond that existing when the thermometric lag was last tested the speed of the cut-out response will not be reduced. In existing installations the recording thermometer bulb shall be located as near as practicable to the bulb of the milk-flow stop. The recording thermometer shall be so designed as to record the times of cut-in and cut-out of the flow-stop.

Cut-out and cut-in temperatures are those temperatures at which milk is prevented from entering the pasteurizer, or allowed to enter the pasteurizer respectively. The cut-out and cut-in milk temperatures shown by the indicating thermometer shall be determined daily by the plant operator and at least monthly by the health officer, and entered upon the recording thermometer chart. This test may be made at any time during the day's run by reducing the steam supply to the heater so as slowly to reduce the milk temperature (not over 1°F. per each 30 seconds). If the flow-stop operates of its own accord at any time during the day's run the above test may be omitted for that day, since the recording thermometer will automatically record the cut-out and cut-in responses.

In case automatically controlled holder heaters are used, as described below under (4) milk-flow stop location, the holder heating medium temperatures at which the holder heater controller cuts out and cuts in the milk flow shall be determined at least monthly by the health officer and entered upon the recording thermometer chart.

Automatic flow-stops shall be so designed that failure of the primary motivating power will automatically stop or divert the flow. All flow-stops shall be so designed and installed that in the stop position subtemperature milk will not enter the forward-flow line. In the case of valve type flow-stops this will require the installation of a leak escape on the forward flow side of the valve seat. However, if back pressure is exerted upon the forward flow side of the valve seat while the milk flow is being diverted the leak escape should lie between two valve seats or between two portions of the same seat, one upstream and the other downstream from the leak escape, as otherwise there would be continuous loss of milk through the leak escape during diversion periods. The leak escape shall be so designed and the valve so installed as to drain all leakage to the outside. For design of leak escapes see heading "Inlet and Outlet Valves and Connections".

The actuating bulb of automatic flow-diversion devices shall be located immediately up-stream from the diversion device (not over one foot distant), since if located downstream forward flow could not be resumed when the required milk temperature is again reached, and since if not located immediately upstream sub-temperature milk may flow forward. It is suggested that automatic milk-pump stops be so connected as simultaneously to stop all milk pumps in the system which would be likely to cause overflow if operating when flow to the holder has stopped. This is better than to stop automatically only the milk pump to the holder proper and depend upon manual operation of a switch to stop other milk pumps in the system.

The thermometric lag of the recorder-controller shall be such as to meet the following test, which shall be applied immediately after installation and at least monthly thereafter. Thermometric lag tests are required because the volume of milk which will pass the flow-stop after the actual milk temperature drops below the pasteurization temperature will increase with the thermometric lag, which is merely a measure of speed of response. Periodic tests are necessary because the lag is not constant but is affected by the smoothness of the recorder chart paper and the pen point, the pressure of the pen arm, and the length of bulb immersion.

a. Adjust the recording thermometer which forms a part of the milk-flow stop

controller to read correctly the pasteurization temperature when checked against a standard test thermometer under approximately constant temperature conditions.

b. Adjust the controller setting so that cut-in will occur when the recording thermometer reads the pasteurization temperature during slowly rising temperatures. This can be done by placing the bulb of the controller in a can of water at 5°F. below the pasteurization temperature and slowly increasing the temperature (as with a steam hose) at a rate not to exceed 1°F. per each 30 seconds.

c. Allow the controller bulb to cool to about room temperature and then immerse it in a can filled with water which has been brought to 7° F. above the pasteurization temperature and is kept agitated. The interval between the moment when the recording thermometer reads 12°F. below the pasteurization temperature and the moment of power cut-in shall be not more than 10 seconds for existing installations and not more than 5 seconds for new installations. The interval between the moment of power cut-out during descending temperatures and the moment when the forward flow of milk ceases shall not exceed 1 second.

4. Milk-flow Stop Location. The milk-flow stop may be located either upstream or downstream from the holder system if the system is so designed that the milk can neither increase nor significantly drop in temperature, as defined below, between the time it leaves the heater and the end of the holding period. A flow-stop shall be located upstream from the holder if any part of the holder is provided with a heating device capable of raising the temperature of milk therein. Otherwise the milk may enter the holder below the leave the holder at or above the pasteurization temperature and thus not have been at the pasteurization temperature for the full holding period. A milk-flow stop shall be located downstream from the holder if the holder is so designed that any particle of milk can drop significantly in temperature after leaving the heater and before the end of the holding period, such as by failure of the holder heater, or by permitting the hot inflowing milk to be cooled, after a shutdown exceeding the holding time, by the cooled holder contents or metal. By significant temperature drop shall be meant a temperature drop of more than 1°F. when all automatically controlled holder heaters, as defined below, are operating continuously, or of more than 2 ½°F. when all automatically controlled holder heaters cease operating at the beginning of the holding period, in both cases with all non-automatically controlled holder heaters cold, as determined by the official tests described below.

An automatically controlled holder heater shall be taken to mean one so designed and connected with the upstream milk-flow stop as to stop the milk flow into the holder when its heating medium drops below the required temperature setting of its thermostat, and so as automatically to restart the milk flow but not before the required temperature is reestablished. Such holder heaters shall be equipped with a thermometer for indicating the temperature of the heating medium. To prevent the heating medium of any holder heater from accidentally becoming a cooling medium ,it shall not be permanently connected with a water make-up line. However, steam heaters which are provided with a trap to eliminate water from the line may be accepted.

Test of "Significant Temperature Drop" in 30 minute holders shall be made by the health officer before such equipment is approved and whenever the seal of the controller setting of the holder heater is broken. The test shall be started with the holders at room temperature. Water may be used in lieu of milk. Turn on all automatically controlled holder heaters, but do not turn on holder heaters not automatically controlled. Operate the system at routine operating temperature for a sufficient period to bring about equilibrium of outlet temperatures, so as to provide standardized preheating of the entire system.

After equilibrium is established, in case automatic adequate agitation, as defined below, is provided observe the milk temperature at the inlet at intervals during filling of one of the holder units and at the outlet shortly after the start of emptying, by means of standardized test thermometers. If the outlet temperature is within 1°F. of the mean inlet temperature, the setting of the thermostat of the automatically controlled holder heater is satisfactory for normal operation. If the outlet temperature is not within 1° F. of the mean inlet temperature, raise the thermostat setting of the holder heater and repeat the test until the outlet temperature comes within 1°F. of the mean inlet temperature. Now repeat the test but with all automatically controlled holder heaters turned off at the beginning of the holding period of one of the holder units, and raise the thermostat setting of the holder heater, if necessary, until the outlet temperature comes within 2½°F. of the mean inlet temperature. Finally, adjust the controller setting of the holder heater so that the milk-flow stop cuts out when the holder heating medium temperature drops below the thermostat setting, and seal this controller setting. The operator should be advised to raise the thermostat setting sufficiently to prevent frequent operation of the cut-out.

In case automatic adequate agitation, as defined below, is not provided, the same procedure is followed except that the thermostat setting of the automatically controlled holder heater is raised, if necessary, until the coldest particle of milk in the holder at any time during the holding period comes within 1°F. and $2\frac{1}{2}$°F., respectively, of the mean inlet temperature. The test shall be conducted in such manner as not to alter the radiation or conduction characteristics of the coldest zone. By automatic adequate agitation is meant adequate agitation, as previously defined, and so designed that the timing mechanism cannot operate unless the agitator is operating.

5. Special Requirements for Systems with the Flow-Stop Located Upstream from the Holder and with none Located Downstream.

   a. Temperature loss during holding period. The system shall be so designed that no particle of milk therein can, from the time it leaves the flow-stop bulb until the termination of the required holding period, drop significantly in temperature, as hereinbefore defined. This limitation of milk temperature drop may be accomplished, so far as the holder is concerned, either by adequate insulation, by automatically controlled holder heating, by insulation combined with such holder heating, or by combining any of these methods with agitation.
   b. Location of Milk-pump Stop Bulb. A milk-flow-stop bulb is a thermometer bulb placed at the milk-flow stop valve, and attached to the thermostat which regulates the automatic opening and closing of the milk-flow stop at the correct temperature. If the milk-flow stop is of the pump-stop type its bulb shall be located in the milk at the farthest downstream point which is within the influence of the heating medium. This means either that the bulb must be located in the heater at its outlet, or that the holder inlet line must be heat-jacketed from the heater to the bulb position but no further.
   c. Gravity flow of subtemperature Milk. Where the milk-flow is of the milk-pump-stop type, all forward gravity flow when the device is in the stop position shall be prevented by some method such as (1) By placing the pump-stop bulb above the level of all milk which lies between it and the nearest upstream point at which the milk is open to the atmosphere, and by locating the latter level below the elevation of the nearest point downstream from the bulb at which the milk emerges to the atmosphere*; or (2) By installing immediately downstream from the bulb a valve which will automatically stop forward flow and drain the inlet line downstream from the bulb when the pump stop goes into the stop position. Where the flow stop is of the flow-diversion type the prevention of all forward flow, including gravity flow, in the stop position is inherent in the design because of the hereinbefore required specifications.
   d. Temperature loss in Holder Inlet Lines. To prevent appreciable milk-temperature drop between the milk-flow-stop bulb and the holder, all inlet lines between the milk-flow-stop bulb and the holder should be as short as practicable, and all milk in all parts thereof shall flow constantly toward the holder when the milk-flow stop is in the forward-flow position, and the inlet lines shall automatically drain completely and quickly either forward into the holder or back to the milk-flow-stop bulb when the milk-flow stop goes into the stop position.

For multiple-holder systems in which the milk inlet line enters the holders above the maximum level of the milk therein, and which have separate inlet valves to each vat or pocket, such inlet valves and the inlet header connecting them shall be at the same level in order to insure automatic drainage when the flow-stop assumes the stop position, and the header must be so looped or otherwise so arranged as to insure constant forward flow at all points and at all times when the flow-stop is in the forward flow position. For holder systems in which the milk inlet line enters the holder at any point below the maximum level of the milk therein, a milk-flow-stop bulb shall, unless the inlet lines are designed to drain back to the bulb or forward into the holder immediately following each assumption of the stop position, be located immediately adjacent to the point at which the milk enters each holder.

   e. Temperature Loss due to Cooled Holder Metal or Contents. In order to prevent the inflowing hot milk from being cooled, after a lengthy shutdown, by the cooled holder contents or metal, all systems in which the milk-flow stop is located upstream from the holder shall be so designed that the milk-flow stop cannot assume the forward-flow position unless the holder metal and the holder contents, if any are at pasteurization temperature.

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* Method (1) may permit the milk to recede from the pump-stop bulb during shutdowns, leaving the bulb surrounded by air and making restarting difficult. This difficulty may be avoided by installing a tight pump or a check valve in the milk line upstream from the stop bulb.

In the case of batch-type holders it may be impracticable to satisfy this requirement automatically. However, a practicable compromise is to provide that after a shut-down exceeding the holding time at least one holder space will be completely emptied either manually or automatically, and will be preheated manually, to receive the first milk entering the holder system upon resumption of forward flow. A Batch-type Holder is one which holds the entire required batch of milk to be pasteurized. A Vat-type Holder is a batch type holder composed of only one compartment. A Pocket-type Holder is a batch type holder composed of a series of several compartments in each of which the pasteurization process is completed in series of intervals allowing a continuous supply of pasteurized milk. Usually these intervals are of 30 minutes durations. This allows 30 minutes for the pasteurization time during which period the compartment containing pasteurized milk is emptied. A Tubular-Holder is one composed of a series of sanitary pipes usually in 10 to 20 feet lengths which are jacketed by pipes usually 1 inch larger in diameter, leaving a space of 1/2 inch surrounding each sanitary pipe. The milk flows through the sanitary pipes and heated water flows through the space around these pipes. The water is heated to the desired temperature for heating and pasteurizing the milk. The milk flows in the opposite direction of the water through the pipes. A Stream-flow Holder is one which is composed of a long line of tubing heated in air or steam jacket through which milk flows at such a rate that the length of time it takes for the milk to flow through the tubing is sufficient to pasteurize the milk.

In the case of short-time installations equipped with a milk-pump stop upstream from the holder, instead of a downstream flow-diversion valve, this requirement may be satisfied automatically by heat-jacketing the entire line between the heater outlet and the holder outlet with a thermostatically controlled heating medium, and by installing a milk-pump-stop bulb (1) in the milk at the holder outlet if said line is not automatically self-draining whenever the milk pump shuts down, or (2) in the heating medium if said line is automatically self-draining; and the bulb shall be so connected as to permit the milk pump to operate only when the bulb temperature is at or above 160°F. *

f. Temperature loss Due to Backflow into Holder. Since the pasteurized milk downstream from the holder may have cooled after discharge, there shall be no backflow of pasteurized milk from the outlet line into any batch-type holder, as such backflow might cool the incoming hot milk. This requirement may be satisfied by providing gravity discharge to a free milk level below the inside bottom of the holder, or by using a positive-type pump and a check-valve at the holder system outlet, or by other satisfactory means.

6. Special Requirements for Systems with the Milk-flow Stop Located Downstream from the Holder.

a. Holder Heating. No part of the system between the holder inlet and the flow-stop bulb shall be heated unless there is also an upstream flow-stop, as otherwise milk entering at a sub-legal temperature might thereafter be raised to the legal temperature and thus be passed by the downstream flow-stop without having been held at pasteurization temperature for the required holding time.
b. Flow-Diversion Type Required. Downstream flow-steps shall be of the flow-diversion type, unless an upstream flow-step and a holder heater are also provided, since a pump-stop bulb must be located within the influence of a heating medium to permit resumption of forward flow, and since such holder heating is prohibited by the preceeding paragraph unless there is also an upstream flow-stop.
c. Simultaneous Temperature Difference. The holder shall be designed so that in the case of a tubular or equivalent stream-flow holder the simultaneous temperature difference between the hottest and the coldest milk in any flow cross-section at any time during the holding period will not be greater than 1°F., and so that in the case of batch-type holders the simultaneous temperature difference between the milk at the center of any holder pocket and the coldest milk in that pocket will not at any time during the holding period be greater than 1°F.
This requirement may be assumed to have been satisfied without test in the case of batch-type holders if the holder is equipped with automatic adequate agitation as previously defined.

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* The effect of cold metal and of cold holder contents is more serious in the case of tubular holders than in the case of batch-type holders, inasmuch as in the former the first small volume of inflowing milk loses considerable temperature, while in the latter the temperature loss is relatively small as mixing distributes it through the entire batch of milk.

This requirement may be assumed to have been satisfied without test in tubular holders of 7 inches or less in diameter, which are free of any fittings through which the milk is not thoroughly swept.

7. Location and Required Readings of Indicating and Recording Thermometers - Both an indicating and a recording thermometer shall be installed and used (1) At the bulb of each milk-flow stop (2) On each vat or pocket of manual discharge systems, and (3) At the outlet of all holder systems with automatic discharge, unless each vat or pocket is so equipped. The bulb of the indicating thermometer shall be located as near as practicable to the bulb of the recording thermometer.

All thermometers located adjacent to milk-flow stop bulbs shall read at least the required pasteurization temperature at all times when the stop is in the forward-flow position. All thermometers located on the holder proper shall read at least the required pasteurization temperature for a period of not less than the following:

a. The required holding time plus the filling time from the level of the recording thermometer bulb, where cooling is begun in the holder simultaneously with, or before, the opening of the outlet valve; and
b. The required holding time plus the filling time and the emptying time from and to the level of the recording thermometer bulb, where cooling is either begun in the holder after the opening of the outlet valve, or is done entirely outside the holder. These filling and/or emptying times shall be determined by the health officer for each vat so operated. All thermometers located at the inlet or outlet of a multiple holder system but not adjacent to a milk-flow-stop bulb shall read at least the pasteurization temperature at all times when milk is flowing past the bulbs of said thermometers; otherwise the milk shall be repasteurized.

No milk or milk products shall be added to batch-type holders after the start of the holding period. The temperature shown by the recording thermometer shall be checked daily by the plant operator and at least monthly by the health officer against the temperature shown by the indicating thermometer, and the readings recorded on the instrument chart. The recording thermometer shall be kept adjusted so as at no time to read higher than the indicating thermometer.

Time Control

8. Insurance of Minimum Holding Period. Each automatic installation shall be so designed as to make it impossible for any milk to be discharged from the holder unless it has been held therein for at least the required holding time. Each manual discharge installation shall be operated to provide the full required holding time for every particle of milk and milk products.

All automatic batch-type installations shall be equipped with a holder timing device driven by a motor the maximum attainable speed of which is such as to insure at least the required holding time. The motor may be either a constant-speed induction-type motor or in lieu thereof any other type of motor which is so connected with a governor as to limit its maximum speed so as to insure the required holding time, provided the setting of the governor is so sealed that it cannot be changed without the knowledge of the health officer. In all cases the motor shall be connected to the timing device by means of a common drive shaft, or by means of gears, pulleys, or a variable-speed drive, with the gear box, the pulley box, or the setting of the variable-speed drive protected in such manner that the holding time cannot be changed without the knowledge of the health officer. Batch-type holders shall be so constructed that milk from one pocket cannot overflow into any other pocket, as otherwise such milk may be discharged from the holder without having been held 30 minutes.

All tubular or equivalent stream-flow holders shall have all holder inlet and outlet pumps connected with a motor system complying with the above requirements for batch-type holder timing devices. Tubular and equivalent stream-flow holders shall be so designed as to prevent the accumulation of air or gases therein, as this may decrease the holding time. Unless the holder slopes continuously upward from inlet to outlet, this will require (1) The installation, at the high point nearest upstream from the holder but downstream from the pump, of an automatic sanitary pipe vent of a type and size which can be easily cleaned, provided that an opening to the atmosphere shall be accepted in lieu thereof, and provided that the installation of automatic vents may be waived if tests by means of a manually operated vent such as a simple valve, located at the above required vent location, demonstrate that no air or gases accumulate in the system after the forward flow of milk has begun, and (2)A continuous

upward slope from the lowest point of the holder to the holder outlet, and also to the vent (or valve) if the latter is at a higher level. The milk may be sucked through the regenerator and the heater, but shall not be sucked through the holder.

In order to insure that all milk will be held for not less than 30 minutes, all 30-minute tubular installations shall comply with the following requirements: (1) The holder outlet shall be equipped with a valve which shall be kept closed until the holder is full and which shall not be opened before the lapse of 30 minutes from the beginning of filling; (2) The holder outlet piping must rise to an elevation above the top of the holder; (3) If there is a pump downstream as well as upstream from the holder the pumps shall be so connected that the downstream pump will stop whenever the upstream pump stops.

9. Required test for Holding Time. Immediately after installation or any replacement or alteration in design or arrangement each pasteurizer shall be tested by the health officer for compliance with the detention requirement. The test shall be made with all valves and any other flow-impeding devices open to their fullest extent, and in case filters are used, with a new filter in place. In the case of pocket-type installations this may be done by checking the timing device with a watch. The interval between the closing of the inlet valve and the opening of the outlet valve should be not less than 30 minutes. In the case of tubular holders this may be done by means of either chloramine, uranine, or starch-iodide pumped through the holder at the pasteurization temperature. The holding time of tubular or equivalent stream-flow holders equipped with a downstream flow-diversion valve shall be tested during both forward flow and diversion.

The following is a suggested method of testing by means of chloramine, uranine, or starch solutions. The inlet to the holder is drilled to receive a one-eighth-inch straightway petcock. A large veterinary-type syringe, with a flat rubber washer slipped over its glass nipple in place of the needle, is filled with a saturated solution of chloramine, uranine (fluorescin), or starch, and the syringe pressed into the petcock opening. In making the injection the petcock is opened, the syringe discharged, and the petcock closed again. The solution is injected after the installation is in smooth operation with water at the pasteurization temperature. The time of beginning injection must be observed accurately. Twenty-five minutes after the solution has been injected the taking of samples at a petcock installed at the outlet end of the holder is begun and continued at 30 second intervals. (For high-temperature short-time pasteurizers the holding time is determined in the same manner, except that sampling is begun 10 seconds after the solution has been injected and continued at intervals of 1 second). These samples are tested for the presence of chloramine, uranine, or starch. The difference in time between injection and appearance at the effluent end is the observed holding time.

All tubular and equivalent stream-flow holders shall be equipped with a petcock at the inlet for the purpose of testing the holding time, also at the outlet unless the outlet discharges to the atmosphere, provided that in lieu thereof the manufacturer may provide the health officer with substitute fittings containing petcocks.

The holding time during filling or emptying of a 30 minute holder may not be identical with the holding time observed for normal flow conditions. The holding time during filling may be determined by (1) Injecting the solution 10 minutes after filling has begun, (2) Opening the effluent valve and beginning routine flow through the holder as soon as the holder is full, but not before the lapse of 30 minutes from the beginning of filling, and (3) Taking samples at the effluent end at 30 second intervals from and after 25 minutes from the time the solution was injected. The holding time is then computed as before. The holding time during emptying may be determined by injecting the solution at the moment the emptying operation begins and observing the time taken to reach the effluent end by taking samples as before.

Record of Temperature and Time

10. Recording Thermometer Charts. Same as Paragraph 4, Page 135 , except that the chart shall contain the following additional information: (h) A record of the time during which the milk-flow stop is in the forward-flow position. (i) The milk temperatures, determined daily, at which the cut-in and cut-out function, and monthly the initials of the health officer opposite the readings. (j) Monthly, the health officer's initials opposite the holder heating medium temperatures at which the controller of the automatically controlled holder heater, if any, cuts out and cuts in the milk flow. (k) Monthly, the thermometer lag of the recorder-controller, as found by official test.

Inlet and Outlet Valves and Connections

Public-Health Reason. Unless the inlet and outlet valves and connections are properly designed and operated, the following conditions may result: (a) Cold pockets of milk may be held in the outlet valve or pipe line; (b) Raw milk may leak into the vat or pocket during the holding or emptying time; or (c) Raw or incompletely pasteurized milk may leak into the outlet lines during the filling, heating, or holding period.

Satisfactory Complaince. Inlet and outlet valves and pipe-line connections to pasteurization holders shall conform with the following design and operation requirements.

Definitions

The following definitions shall apply in connection with these specifications:

1. A 90° stop shall mean a stop so designed as to prevent turning the plug more than 90°. .... A 180° stop shall mean a stop which prevents turning the plug more than 180°, but which permits two "fully closed" positions, each diametrically opposite the other. A valve with an irreversible plug shall mean one in which the plug cannot be reversed in the shell. A single quadrant stop shall mean a 90° stop in a valve with an irreversible plug.

2. The fully-open position shall mean that position of the valve seat which permits the maximum flow into or out of the holder. The closed position shall mean any positiòn of the valve seat which stops the flow of milk into or out of the holder. The fully-closed position shall mean the position of the valve which requires the maximum movement of the valve to reach the "fully open" position. The just-closed position shall mean, in the case of a plug-type valve, that position of the plug in which the flow into or out of the holder is just stopped, or any closed position within 5/64 inch thereof as measured along the circumference of the valve seat.

3. Leakage shall be taken to mean the entrance of unpasteurized milk into a pasteurization holder during the holding or emptying period or the entrance of unpasteurized milk into any pasteurized-milk line at any time.

4. A leak-protector valve shall mean a valve which is provided with a leak-diverting device which, when the valve is in any closed position *, will prevent leakage of milk past the valve or, in the case of holders filled or emptied by suction or compressed air, will prevent leakage of milk due to the leakage of air past the suction valve or the compressed-air valve, as the case may be.

5. A close-coupled valve shall mean a valve the seat of which is either flush with the inner wall of the holder or so closely coupled that all milk in the valve pocket is not more than 1°F. Colder than the milk at the center of the holder at any time during the holding period; provided that in the absence of tests to the contrary, a close-coupled valve which is not truly flush shall be considered as satisfying this requirement (a) if the holder outlet is so flared that the smallest diameter of the large end of the flare is not less than the diameter of the outlet line plus the depth of the flare, and (b) if the greatest distance from the valve seat to the small end of the flare is not more than one and one-half times the diameter of the outlet line, and (c) if, in the case of vat and pocket holders, the outlet and the agitator are so placed as to insure that milk currents will be swept into the outlet.

Design

All valves and connections shall comply with the following requirements:

1. Valves and pipe-line connections shall be constructed in such a manner as to be easily cleaned and kept in good repair.

2. All pipe lines and fittings shall be so constructed and located that "leakage" will not occur.

3. Dependence shall not be placed on soldered joints to prevent "leakage".

4. All multiple vat or pocket insatllations shall be equipped with leak-protector inlet and outlet valves (see definition of leak-protector valved for compressed air systems)

* For existing valves the term "any closed position" may be limited in meaning to the fully closed or approximately fully closed position.

provided that existing installations for which no satisfactory leak-protector outlet valve can be reasonably provided shall be considered satisfactory if (a) each vat is disconnected from the outlet piping during the filling, heating and holding periods, and (b) the outlet piping is so arranged that only one vat can be connected to the discharge line at a time. All inlet and outlet valves, if any, on single-vat installations shall be of the leak-protector type, except in the case of existing installations. For leak escapes on flow-diversion valves see heading, "Specifications to Insure that the Required Pasteurization Temperature and Time will be Applied to Every Particle of Milk."

5. Leak-protector valves shall be provided at the outlets of all 30 minute tubular holders, or the outlet piping shall be left disconnected until at least 30 minutes after the filling of the holder is begun.

6. Inlet and outlet connections other than through "close-coupled valves" shall not enter or leave the holder below the level of the milk therein. This is in order to insure adequate pasteurization of all milk in inlet and outlet connections.

7. To prevent clogging and to promote drainage all grooves shall be at least 3/16 inch wide and at least 3/32 inch deep at the center.

8. Mating grooves shall provide this full cross-section area throughout their combined length whenever the valve is in or approximately in the " fully-closed position ".

9. All single leak grooves and all mating leak grooves when mated shall extend throughout the entire depth of the seat, so as to divert"leakage" occurring at all points throughout the depth of the seat, and so as to prevent air binding.

10. All valves shall be so located as to be readily accessible for cleaning.

11. Washers or other parts shall not obstruct leak-protector grooves.

12. A stop shall be provided on all plug-type outlet valves and on all plug-type inlet valves hereafter installed in order to guide the operator in closing the valve so that unpasteurized milk may not inadvertently be permitted to enter the outlet line or the holder, respectively. The stop shall be so designed that the plug will be "irreversible" if the plug is provided with any grooves or their equivalent, unless duplicate, diametrically opposite grooves are also provided. In the case of two-way plug type valves (i.e. those having only one inlet and one outlet), a 180° stop or any combination of stops permitting two fully-closed positions may be substituted for a 90° stop if there are no air-relief grooves in the plug and if all leak grooves are located symmetrically with respect to the valve inlet.

13. All leak-protector valves shall be installed in the proper position to insure the proper functioning of the leak-diverting device.

Inlet valves and connections shall, in addition, comply with the following requirements:

1. Pipe lines between the inlet valve and holder shall be as short as practicable, and shall be sloped to drain.

2. In cases where the inlet line enters the holder above the milk level and in which the inlet line may be submerged and thus prevent its complete emptying when the inlet valve is closed, the inlet line shall be provided with an automatic air relief located either at the valve or elsewhere and so designed as to function in every closed position of the valve. In the case of vat and pocket holders a vent may be provided by drilling a hole at least 1/8 inch in diameter in each vat or pocket inlet pipe below the vat or pocket cover but above the maximum milk level.

Outlet valves shall, in addition to the requirements listed above under "all valves and connections", be designed so as to prevent the accumulation of unpasteurized milk in the milk passages of the valve when the valve is in any closed position; or, in lieu thereof, shall be provided with steam or hot water connections for bactericidal treatment; provided that these alternatives shall not be required in the case of valves on existing single-vat installations. Such connections for bactericidal treatment shall (a) open automatically when the milk valve is closed and close automatically when the milk valve is opened, except in the case of existing manually operated valves, and (b) be of sufficient size and so operated as not to clog readily.

Operation

Existing single-vat installations, if not provided with "leak-protector" inlet valves, shall be disconnected from the raw milk supply during the holding and emptying periods, and, if not provided with "leak-protector" outlet valves, shall be disconnected from the outlet piping during the filling, heating, and holding periods. All outlet valves shall be kept "fully closed" during the holding and emptying periods.

All outlet valves required above to be provided with connections for bactericidal treatment shall immediately before the discharge of pasteurized milk be given bactericidal treatment for at least 2 minutes at 170° F. or more, or for at least 30 minutes at 143°F. or more. In the case of existing single-vat installations bactericidal treatment shall be accomplished by injecting steam or 170°F. water into the valve for not less than 2 minutes from a hose, or by any other method approved by the health officer.

Air Heating

Public-Health Reason. Tests have shown that when foam is present on milk in vats and pockets during pasteurization the temperature of the foam may be well below the pasteurization temperature. In such cases all pathogenic organisms in the foam may not be killed. In filling vats, splash frequently occurs on the surfaces of the vat and the fixtures above the milk level as well as on the underside of the vat cover and cools off. Portions of this splash may drop back into the body of the milk. When the air above the milk is heated to above pasteurization these conditions are remedied. Many plant operators have reported that the use of air heaters (especially with partly filled vats and vats with uninsulated lids) makes it easier to maintain a uniform and sufficiently high temperature of the milk itself.

Satisfactory Compliance. For holders of vat or pocket types, means shall be provided and used which will keep the atmosphere above the milk at a temperature at least 5°F. higher than the existing milk temperature during the heating period and at least 5°F. higher than the required temperature of pasteurization during the holding period. If steam is admitted into the holder, the steam line shall be provided with a trap properly designed to avoid the discharge of water into the milk. In all cases an approved air temperature indicating thermometer shall be installed.

Air Temperature Indicating Thermometers

Type. V-shaped brass or equally noncorrodible scale case with removable glass front, mercury actuated, bottom of bulb chamber not less than 2 inches and not more than 3½ inches below under side of cover, filling above mercury, nitrogen or equally suitable gas.
Magnification of Mercury Column. To apparent width of not less than one-sixteenth inch.
Scale Range. 130° to 210°F., extension either side permissive, protected against damage at 220° F.
Temperature Represented by Smallest Scale Division. Not more than 2°F.
Number of Degrees per Inch of Scale - Not more than 16.
Accuracy. Within 1°F., plus or minus, throughout specified scale range.
Stem Fitting. I.A.M.D. ferrule or other sanitary fitting.
Bulb. Corning normal or equally suitable thermometric glass.

Vat and Pocket Cover and Cover Ports

Public Health Reason. Obviously, if the vat and pocket covers are not constructed so as to prevent the entrance of water, leakage, and dust, the milk may be contaminated with such material, which in turn might contain disease bacteria, since it is from nondisinfected surfaces. Keeping the covers closed during operation reduces the change of dust, flies, sputum droplets, drip, and splash entering the milk.

Satisfactory Compliance. The covers of vats must be so constructed that nothing on top thereof will drop into the vat in either their open or closed position. Some vat covers are so designed that pools of milk or condensation, etc., which may have accumulated on top of the covers may drop into the milk. This sometimes occurs through opernings in the cover or by drip over the back edge of the cover into the vat when the cover is raised. Inasmuch as the material thus entering the vat may be contaminated, it is necessary that the cover be so designed as to overcome this objection. This may be done by means of vertical fins, overlapping edges, and setback hinges. It will usually be a simple matter for the plant owner to have a tinner make the necessary corrections in the design of the cover. All openings through the cover shall have a raised edge to prevent drainage into the opening. Condensation diverting aprons shall be provided as close to the cover as possible on all pipes, thermometers, and other equipment extending through the cover and on which condensation may form, unless a water-tight joint with the cover is provided.

Preheating Holders

Public-Health Reason. Cold vats or pockets may cool the first milk entering them to below the pasteurization temperature.

Satisfactory Compliance. All holders used for holding milk which has been heated to the pasteurization temperature before entering the holders shall be preheated with steam or otherwise so that the metal shall be at least at the pasteurization temperature before milk is admitted at the beginning of the day's run,and all empty holders shall be similarly preheated or the temperature shall be otherwise maintained after a shutdown exceeding the holding time, unless the holder outlet is equipped with an automatic flow-diversion valve. Where preheating at the beginning of the run is done by means of steam admitted near the top of the holder, such as the air heater, the outlet valve shall be opened to permit a flow of steam so as adequately to heat the metal in the bottom of the holder.

Cooling.

All milk and milk products received for pasteurization shall immediately be cooled in approved equipment to 50°F. or less and maintained at that temperature until pasteurized, unless they are to be pasteurized within two hours after receipt and all pasteurized milk and milk products shall be immediately cooled in approved equipment to an average temperature of 50° F. or less and maintained thereat until delivery.

Public-Health Reason. If milk is not cooled within a reasonable time after it is received at the pasteurization plant its bacterial count will be materially increased. The same public-health reason applies to the cooling of the milk and milk products after pasteurization.

Satisfactory Compliance. This item shall be deemed to have been satisfied if

1. All milk and milk products intended for pasteurization, but not to be pasteurized within 2 hours after receipt at the plant or cooling station, are cooled immediately on receipt to 50°F. or below, and maintained thereat until pasteurized.

2. All pasteurized milk and milk products are cooled immediately after pasteurization to 50°F. or below and maintained at that average temperature, until delivery.

3. All new surface coolers, as well as all regenerators, where so specified below, meet the following specifications. For existing equipment only (d),(e), and (f) are required.

   a. The sections of open-surface coolers shall be installed so as to leave a gap of at least one-fourth inch between the header sections to permit easy cleaning, unless the gap is at least equal to the thickness of the header lengthwise of the section.
   b. Where header ends are not completely enclosed within the cooler covers, condensation or leakage from the headers shall be prevented from entering the milk by so shaping the exposed header faces above and below all gaps as to direct condensation away from the tubes, and by the use of deflectors at the bottom of the headers or by shortening the bottom trough or by other approved method.
   c. The supports of the cooler sections shall be so located as to prevent drip therefrom reaching the milk.
   d. Recirculated water and refrigerant used in coolers and regenerators shall be properly protected or treated so as to comply at all times with the quality standards of safe water supply. Such water or refrigerant may be under greater pressure than the pasteurized milk and may contaminate the latter if flaws develop in the joints or the metal separating the two.
   e. All open-surface coolers and open-surface regenerative coolers shall be located in a separate well ventilated room or shall be provided with tight-fitting shields preferably suspended on trolleys. Special exceptions may be made by the health officer when clearly warranted. The health officer is clearly warranted in making exceptions only when the room is so constructed and the cooler is so located as to eliminate all danger of contamination by flies, dust, drip, splash, manual contact, and droplet infection from coughing and sneezing. If the milk surface of the pasteurized-milk cooler is exposed at least part of the service rendered by pasteurization is nullified, since the milk cooler represents the largest single exposure of milk which takes place at any time in its course. The ideal requirement is, obviously, that pasteurized milk shall not be exposed again from the moment pasteurization begins until the pasteurized milk is in the bottle. A separate cooler room shall be taken to mean a room used exclusively for the cooler and through which there is no traffic except for work necessary for the operat

of the cooler. The shields shall be tight fitting and shall effectively protect all milk surfaces from contamination by flies, dust, drip, splash, manual contact, and droplet infection.

f. Regenerative heater-coolers shall be so constructed, installed, and operated that, in the case of milk-to-milk regenerators, the pasteurized-milk side will automatically be under greater pressure than the raw milk at all times, and, in the case of milk-to-water-to-milk regenerators, the heat-transfer-medium side will automatically be under greater pressure than the raw milk at all times.
This will prevent contamination of the pasteurized product by the raw milk in case flaws develop in the metal or the joints separating the two. In the case of milk-to-water-to-milk equipment the intent of this requirement is to prevent the raw milk from contaminating the heat-transfer medium which in turn could contaminate the pasteurized product. The heat-transfer water, for which a potable supply must be used and which is confined in a closed circuit and is periodically reheated by the pasteurized milk, will not contaminate the latter unless such medium has first been mixed with raw milk. The pasteurized product could also be properly protected by requiring that it be kept at all times under higher pressure than the heat-transfer water, but this alternative method would not prevent the objectionable fouling of the water by the raw milk if flaws developed in the metal or the joints between them.
The following methods will automatically insure the required relative pressures in the various types of regenerators described. These or equally satisfactory means of complying with this provision shall be required by the health officer.

Milk-to-Milk Regenerators

Four types of milk-to-milk regenerators are possible. In the most common design both the raw milk and the pasteurized product flow through either a series of connected plates or two concentric pipes, so that both sides are closed to the atmosphere. In others the pasteurized milk is on the inside of a pipe, while the raw milk flows downward on the outside open to the atmosphere. The third design is like the second, but the raw milk is on the inside and the pasteurized on the outside. In the fourth possible type, not used at present, the raw milk flows downward on one side of a corrugated partition and the pasteurized on the other side, with both sides open to atmospheric pressure.

In milk-to-milk regenerators with both sides closed to the atmosphere, Figure 5, the required relative pressures will be automatically insured when the following conditions obtain:

1. The pasteurized milk, between its outlet from the regenerator and its nearest downstream point open to the atmosphere, rises to an elevation higher, by at least three percent of the static raw-milk head on the bottom of the regenerator, than any raw milk between the free raw-milk level nearest upstream and that nearest downstream from the regenerator, provided that such excess head is at least six percent if water or chlorine solution is introduced ahead of the milk at the beginning of a run; and

2. No pump is located between the pasteurized milk outlet from the regenerator and the nearest downstream point open to the atmosphere; and

3. No pump is located between the raw-milk inlet to the regenerator and the free raw-milk level nearest upstream therefrom; and

4. A back-flow preventing device, such as a positive-type pump or a check valve, is installed in the line between the pasteurized-milk inlet to the regenerator and either the nearest upstream point open to the atmosphere or the raw-milk outlet from the regenerator, whichever is farther downstream; provided that if said valve or pump or any portion of the system downstream therefrom leaks, storage for the pasteurized milk shall be provided downstream from its outlet from the regenerator and at the elevation specified in 1, either in the pipe line or in a tank equipped with a bottom inlet, equal in volume to at least one hour's leakage; and

5. Either (a) the free raw-milk level nearest upstream from the regenerator is in a tank the overflow of which is below the level of the lowest milk passage in the regenerator, and all raw milk in the regenerator drains freely into such tank when the raw-milk line is disconnected from the regenerator outlet; or (b) the free raw-milk level nearest upstream from the regenerator is in a tank the overflow of which is below the level of the lowest milk passage in the regenerator, and hot water or chlorine solution or previously pasteurized milk is introduced into the pasteurized milk side of the regenerator up to the elevating specified in (1) before any raw milk is admitted to the regenerator and is so maintained until replaced by the freshly pasteurized milk (not by air).

The reasons for these specifications may not be apparent. If (1) is satisfied all pasteurized milk in the regenerator will be under greater pressure than the raw milk, provided (2) and (3) are satisfied during operation, (4) during shut-downs, and (5) at the beginning of the run.

The three % excess head provided in (1) is intended to compensate, during shut-downs, for the difference in specific gravity between pasteurized milk at 160°F. and raw milk at 40°F. Similarly, the six percent excess head required when water or chlorine solution is used at the beginning of a run serves to compensate, during shut-downs occurring at the beginning of a run, for the difference in specific gravity between water at 160°F. and milk at 40°F.

A pump located as described in (2) could during operation reduce the pasteurized milk pressure on its suction side to below that of the raw milk in the regenerator.

When the raw milk is sucked through the regenerator, an auxiliary pump provided with slip is sometimes located as described in (3), in order to overcome possible priming difficulties in the main pump and to maintain the raw milk in the regenerator at or above atmospheric pressure so as to avoid sucking in air. A raw-milk pump upstream from the regenerator could increase the raw-milk pressure to above that of the pasteurized milk in the regenerator during operation even if (1) and (2) were satisfied. It is possible to avoid this objection by placing in the pasteurized-milk line downstream from the regenerator a sufficient gravity head of pressure-increasing restriction, as by means of a valve. Whether such gravity head or restriction is sufficient to accomplish its purpose would have to be determined for each installation and for every change in the hook-up by means of pressure gages. Proper relative pressures could not be automatically insured.

The positive-type pump or the check valve specified in (4) will prevent backflow of the pasteurized milk through the regenerator, provided no leakage occurs. A flow-diversion valve cannot be relied upon to prevent backflow during the first few minutes following a pump shut-down while the milk is still at a sufficiently high temperature to keep the diversion valve in the forward-flow position. Back-flow would lower the level of the pasteurized milk during pump shut-downs and thus might reduce its pressure to below that of the raw milk in the regenerator. The first alternative location for the device applies to systems with pasteurizer holders or other intermediate tanks open to the atmosphere; the second, to completely closed systems. The second provision of (4) will insure an adequate pasteurized-milk pressure throughout a shut-down of at least 1 hour's duration, even if there is some backflow due to leakage. Shut-downs of such duration are infrequent. The adequacy of the storage provided to compensate for leakage should be checked monthly by determining, by means of a petcock installed in the line at the elevation specified in (1) whether the pasteurized milk in the line has fallen below the specified level after a pump shut-down of 1 hour. If such petcock is opened momentarily and no milk escapes, additional storage is needed, the volume of which may be determined with a sterile probe.

At the beginning of a run the raw milk in the regenerator may be under greater pressure than the pasteurized-milk side from the time the raw milk enters the regenerator until the pasteurized milk has risen to the elevation specified in (1) downstream from and above the regenerator. In the case of 30 minute pasteurizers this may take an hour longer, during which period the pasteurized-milk side of the regenerator is at atmospheric pressure. With the raw-supply tank lower than the regenerator, as required by both alternative methods described in (5) for overcoming this danger, all raw milk in the regenerator will be at subatmospheric pressure as long as the pump is operating. If, however, this suction draws air into the regenerator through a leaky gasket (which may long go undiscovered because no milk would leak to the outside), and if the pump shuts down longer than momentarily during this period (as may frequently happen when a milk-pump stop is used), the suction would soon be destroyed and the raw-milk pressure could increase up to atmospheric, or even above atmospheric in plate-type regenerator. For this reason both alternative methods require additional safeguards. Under the above circumstances the free-draining regenerator specified in the first method will automatically insure sub-atmospheric pressure as long as the raw milk remains in the regenerator. In the second method water or chlorine solution or previously pasteurized milk will temporarily provide the necessary pressure on the pasteurized-milk side until replaced by the freshly pasteurized milk. Since the operator may at times fail to do this, the first method is superior because it is completely automatic. Hence all new regenerators of this type should preferably be designed to be free-draining.

In the second method the water or chlorine solution or previously pasteurized milk may either precede the raw milk, through the entire system or may be introduced into the system at a point downstream from the holders. In the latter case the level of the liquid, once introduced, will have to be maintained by a valve until replaced by the freshly pasteurized milk; and an air vent will have to be provided immediately upstream from the valve to permit discharge of the air in the system ahead of the raw milk, otherwise such air may be

sufficient in quantity to push all of the liquid out of the pressure leg and thus reduce to atmospheric the pressure on the pasteurized-milk side of the regenerator. In this case the operation at the beginning of a run would proceed by the following steps: (1) Introduce the liquid into the pasteurized-milk side of the regenerator until it reaches the required elevation; (2) Shut off the valve; (3) Open the air vent; (4) Start the raw milk through the regenerators; (5) At the moment milk begins to discharge from the air vent, open the valve and close the air vent.

In milk-to-milk regenerators with only the raw milk open to atmosphere (Figure 6) the required relative pressures are automatically insured when

a. The pasteurized milk, between its outlet from the regenerator and its nearest downstream point open to the atmosphere, rises higher than the top of the regenerator, and;
b. No pump is located between the pasteurized-milk outlet from the regenerator and the nearest downstream point open to the atmosphere; and
c. A backflow-preventing device, such as a positive-type pump or a check valve, is installed in the line between the pasteurized-milk inlet to the regenerator and either the nearest upstream point open to the atmosphere or the raw-milk outlet from the regenerator, whichever is farther downstream; provided that if said valve or pump or any portion of the system downstream therefrom leaks, storage for the pasteurized milk shall be provided downstream from its outlet from the regenerator, either in the pipe line or in a tank equipped with a bottom inlet, at a higher elevation than the top of the regenerator, equal in volume to at least 1 hour's leakage; and
d. Hot water or chlorine solution or previously pasteurized milk is introduced into the pasteurized-milk side of the regenerator up to the elevation specified in (a) before any raw milk is admitted to the regenerator and is so maintained until replaced by the freshly pasteurized milk (not by air). Since this operation is necessarily manual, and no design method is apparent which will, at the beginning of a run, automatically insure a higher-than-atmospheric pressure on the pasteurized-milk side of the regenerator, this type of regenerator should not be approved for new installations.

The reasons for these specifications are similar to those for the preceeding type. In both designs the purpose is to maintain the pasteurized product under greater pressure than the raw at all times, the only difference being that where the raw milk is open to the atmosphere the pasteurized milk need be kept only above atmospheric pressure rather than at a higher level than all raw milk in the system. If (a) is complied with all pasteurized milk in the regenerator will be under greater pressure than atmospheric, provided (b) is satisfied during operation, (c) during shut-downs, and (d) at the beginning of the run. In this type there is no objection to a raw-milk pump upstream from the regenerator, since the raw-milk side is open to the atmosphere and cannot be above atmospheric pressure.

In milk-to-milk regenerators with only the pasteurized milk open to the atmosphere (Figure 7) the required relative pressures are automatically insured when

a. No pump is located between the raw-milk inlet to the regenerator and the free raw-milk level nearest upstream therefrom; and
b. The free raw-milk level nearest upstream from the regenerator is in a tank the overflow of which is below the level of the lowest milk passage in the regenerator; and
c. All raw milk in the regenerator drains freely into such tank when the raw-milk line is disconnected from the regenerator outlet.

The reasons for these specifications differ somewhat from the preceding type, inasmuch as any raw milk in the regenerator must at all times be maintained at subatmospheric pressure. Provisions (a), (b), and (c) will automatically insure this not only during operation and during pump shutdowns but also at the beginning of a run, for the same reason as that given in the discussion of paragraph 5 of the first type described.

Milk-to-milk regenerators with both sides open to the atmosphere should not be approved, since with both sides at atmospheric pressure the pasteurized-milk side cannot ever be under greater pressure than the raw-milk side. This type of regenerator is not, however, being used nor is it likely to be used because of its inefficiency. It is subject to large heat losses to the atmosphere, and as the raw milk and the pasteurized milk must both flow downward it cannot utilize counter-current flow.

Milk-To-Water-To-Milk Regenerators

Many types of milk-to-water-to-milk regenerators could be designed, but only the two types on the market will be discussed. The number of possible combinations may be gaged by the fact that in either or both the raw-milk and the pasteurized-milk sections both the milk

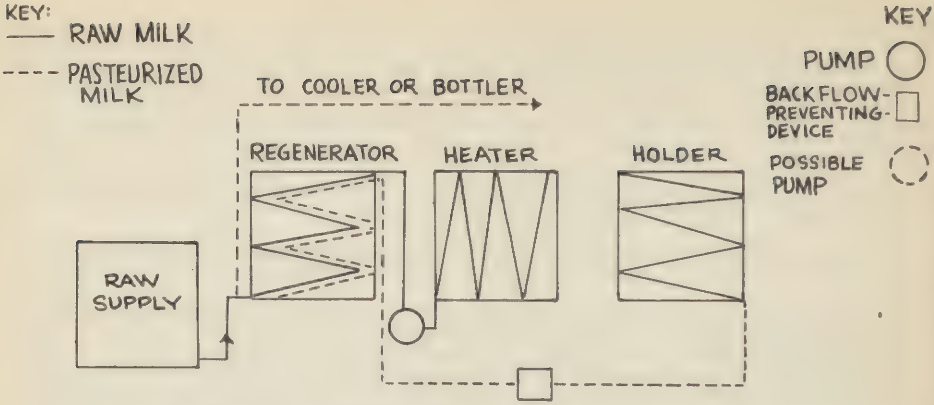


FIGURE 5.- MILK-TO-MILK REGENERATOR WITH BOTH SIDES CLOSED TO ATMOSPHERE (DIAGRAMMATIC ELEVATION)

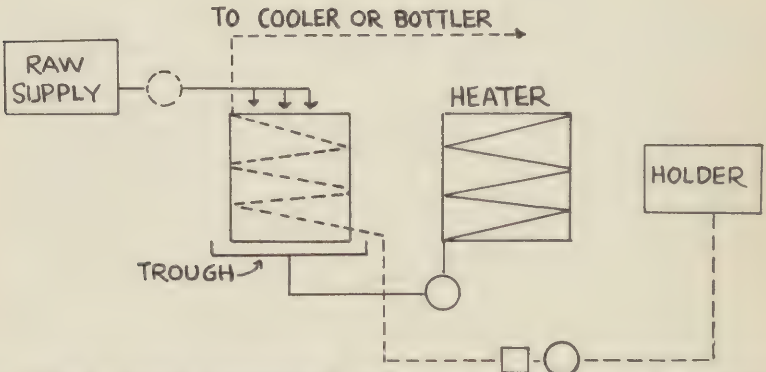


FIGURE 6. MILK-TO-MILK REGENERATOR WITH ONLY RAW MILK OPEN TO ATMOSPHERE (DIAGRAMMATIC ELEVATION)

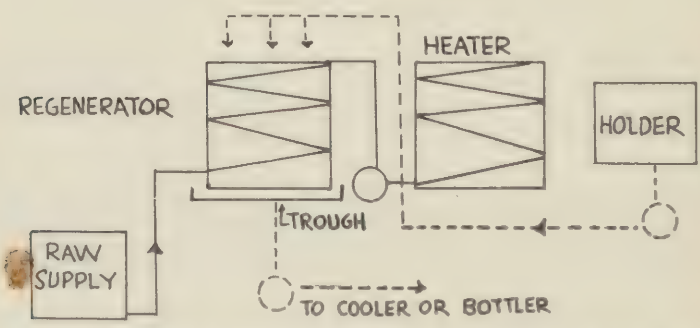


FIGURE 7. MILK-TO-MILK REGENERATOR WITH ONLY PASTEURIZED MILK OPEN TO ATMOSPHERE (DIAGRAMMATIC ELEVATION)

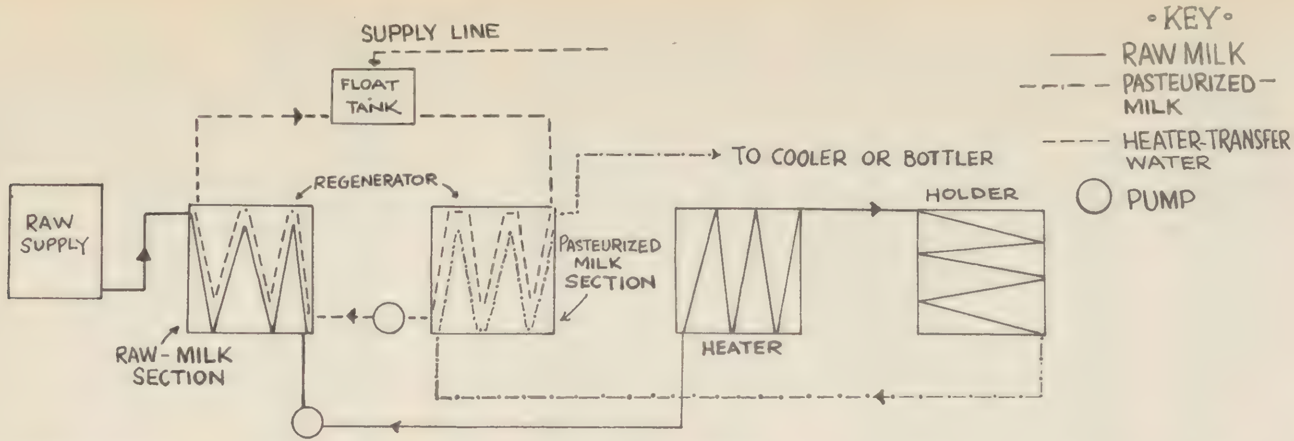


FIGURE 8.— MILK-TO-WATER-TO-MILK REGENERATOR WITH BOTH MILK AND WATER IN RAW-MILK SECTION CLOSED TO ATMOSPHERE (DIAGRAMMATIC ELEVATION)

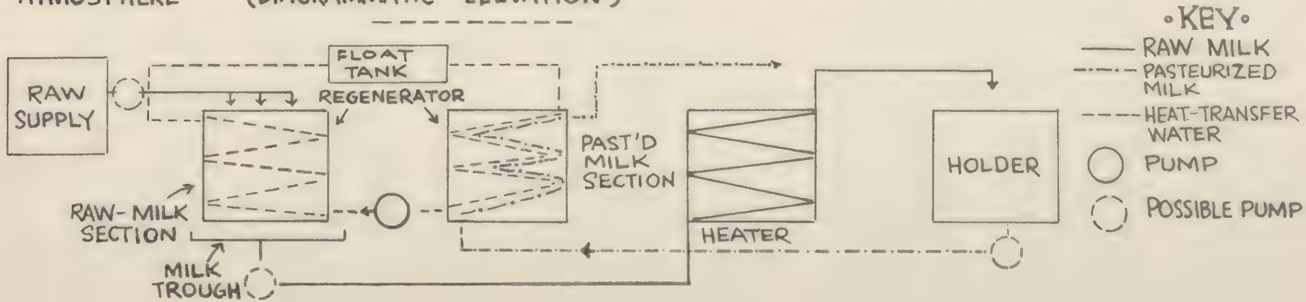


FIGURE 9. MILK-TO-WATER-TO-MILK REGENERATOR WITH WATER CLOSED BUT MILK OPEN TO ATMOSPHERE IN RAW MILK SECTION (DIAGRAMMATIC ELEVATION)

and the heat-transfer medium may be either open or closed to the atmosphere. In connection with the relative-pressure requirement, conditions existing in the pasteurized-milk section are immaterial and only the raw-milk section need be considered.

In milk-to-water-to-milk regenerators with both the milk and the heat-transfer water in the raw-milk section closed to the atmosphere (Figure 8) the required relative pressures are automatically insured if -

a. The highest point of the heat-transfer-water circuit is in a covered tank at an elevation higher, by at least 6 percent of the static raw-milk head on the bottom of the regenerator, than any raw milk between the free raw-milk level nearest upstream and that nearest downstream from the regenerator; and
b. No heat-transfer water pump is located in that portion of the heat-transfer-water circuit which lies upstream from such tank and downstream from the heat-transfer-water inlet to the raw-milk section of the regenerator; and
c. No milk pump is located between the raw milk inlet to the regenerator and the free raw-milk level nearest upstream therefrom; and
d. The heat-transfer-water circuit is full of water at the beginning of the run, and all loss of water from the circuit (through back-siphonage, open drain valve, leakage, evaporation, etc.) is prevented or automatically and immediately replenished whenever raw milk is present in the regenerator.

Most of these requirements and the reasons thereforeare similar to those already discussed for milk-to-milk regenerators with both sides closed to the atmosphere. Compliance with (a) will place all of the heat-transfer water in the raw-milk section of the regenerator under greater pressure than the raw milk at all times, provided (b), (c), and (d) are also satisfied. The excess head specified in (a) for the heat-transfer-water circuit will compensate, during shut-downs, for the difference in specific gravity between milk at 40°F. or less and water at 160°F. or more.

A heat-transfer-medium pump located as described in (b),could, when operating, reduce the heat-transfer-water pressure on its suction side to below that of the raw milk in the regenerator. A milk pump located as shown in (c) could during operation increase the raw-regenerator even if all other requirements were satisfied.

The full heat-transfer-water circuit required at all times by (d) is considered the simplest means of insuring proper relative pressures. The heat-transfer-water pump could, when operating, satisfy the pressure requirement even if the circuit were not full; but when not operating it will not satisfy this requirement unless there is enough water in the circuit to fill the upstream portion between the pump and the tank, and unless all backflow and loss of water from this portion of the circuit are prevented. The most practical solution, is, therefore, a constant-level tank at the highest point specified in (a). A covered tank will protect the water against contamination, but the cover should not be airtight. Although the float in the tank will automatically open the supply-line valve whenever any loss of water from the circuit occurs, the drain valve should be kept closed throughout the day's run to avoid unnecessary risks. The tank should be supplied with an overflow, and all supply lines feeding the heat-transfer-water circuit should enter at the tank and through a sufficient air gap to prevent loss of water through backsiphonage into the supply line.

In milk-to-water-to-milk regenerators with the water closed but the milk open to the atmosphere in the raw-milk section (Figure 9), the required relative pressures are automatically insured when the following conditions are satisfied:

a. The highest point of the heat-transfer-water circuit is in a covered tank at a higher elevation than the top of the raw-milk section of the regenerator; and
b. No heat-transfer-water pump is located in that portion of the heat-transfer-water circuit which lies upstream from such tank and downstream from the heat-transfer-water inlet to the raw-milk section of the regenerator; and
c. The heat-transfer-water circuit is full of water at the beginning of the run, and all loss of water from the circuit (through backsiphonage, open drain valve, leakage, evaporation, etc.) is prevented or automatically and immediately replenished whenever raw milk is present in the regenerator.

These specifications and the reasons thereforeare almost identical with those of the type immediately preceding, except that the raw-milk pump upstream from the regenerator is not prohibited since the raw-milk pressure in this type of regenerator cannot exceed atmospheric.

Bottling

Bottling of milk and milk products shall be done at the place of pasteurization in approved mechanical equipment.

Public-Health Reason. Hand-bottling is very apt to result in the exposure of the milk and

milk products to infection, which would nullify the effect of pasteurization.

Satisfactory Compliance. This item shall be deemed to have been satisfied if the bottling is done by mechanical equipment conforming with the following requirements:

The term "mechanical equipment" is not interpreted to exclude machinery operated by man power, but is interpreted to exclude methods in which the bottling and capping devices are not integral in one machine.

1. The bottler is of a design which does not require frequent adjustment during operation, thus exposing the milk to danger of contamination.

2. Bottling machine supply tanks and bowls are provided with covers which are so constructed as to prevent any contamination reaching the inside of the bottler tank or bowl.

3. Bottler floats are so designed as to be adjustable without removing the cover.

4. The filler pipe of the bottler is provided, as close to the top of the bottler as possible, with an apron or other approved device to prevent water of condensation or drip from fingers reaching the inside of the bottler during float adjustments. Bottler designs which do not include filler pipes or floats shall not be required to comply with items (3) or (4).

5. Automatically operated bottler infeed conveyors are provided with overhead shields from the bottle washer to the bottler feed star to protect the bottles from contamination. Overhead shields shall also be required on can infeed conveyors if the cans are fed to the filler with covers off.

Overflow Milk

Overflow milk or milk products shall not be sold for human consumption.

Public Health Reason. Milk or milk products which have come in contact with equipment surfaces which have not been treated with a bactericide and safeguarded after treatment, have been exposed to contamination, and are therefore dangerous.

Satisfactory Compliance. This item shall be deemed to have been satisfied so long as there is no evidence of the use of spilled or overflow milk or milk products for delivery to consumers.

Capping

Capping of milk and milk products shall be done by approved mechanical equipment. Hand capping is prohibited. The cap or cover shall cover the pouring lip to at least its largest diameter.

Public Health Reason. Hand capping is apt to expose the milk to contamination. The pouring lip of the bottle may be contaminated by handling. A cover extending over the pouring lip prevents the sucking back into the bottle by temperature contraction of any milk which has been squeezed out by temperature expansion and which may have become contaminated.

Satisfactory Compliance. For definition of "Mechanical Equipment" see heading "Bottling". This item shall be deemed to have been satisfied if

1. All bottlers are equipped with a mechanical capping mechanism of a design which does not require frequent adjustment.

2. Bottles imperfectly capped are dumped into cans or other containers and the dumped milk or milk products repasteurized.

3. The cap or cover of all containers covers the pouring lip to at least its largest diameter.

Attempts to adjust caps by hand, or to remove them and recap either by hand or by machine, inevitably expose the milk in the bottle to manual contamination. The substitution of a pick for the fingers in removing caps does not prevent manual contamination inasmuch as the point of the pick, which often touches the milk, is exposed to contamination from the fingers, etc.

BUTTER, CHEESE AND OTHER MILK PRODUCTS REGULATIONS OF THE LOUISIANA SANITARY CODE

Definitions. The following definitions shall apply in the interpretation of these regulations:

Butter is the clean, sound, food product made by gathering, in any manner, the fat of fresh or ripened milk, or cream into a mass which also includes a small portion of other constituents natural to milk, with or without common salt, with or without additional harmless food coloring and which contains in the finished product not less than 80 percent by weight of milk fat, all tolerances being allowed for.

Renovated Butter - Process Butter - is the product made by melting butter and reworking butter without the addition or use of chemicals or any substances except milk or cream, with or without salt and with or without additional harmless food coloring. It contains in the finished product not more than sixteen (16%) percent of water and not less than eighty (80%) percent by weight of milk fat, all tolerances having been allowed for.

Creamery Butter shall be considered to mean butter manufactured in a butter plant or creamery, and shall conform to the definition of butter as given above.

Country Butter shall be considered to mean butter manufactured at a dairy farm or establishment other than a regular butter manufacturing plant or creamery, and shall conform to the definition of butter as given above. No country butter shall be offered for sale except that which is manufactured in a room or establishment that meets the following requirement: Adequate lighting facilities, doors and windows effectively screened, having no direct opening into stable or living quarters, impervious floors, proper equipment for cleaning and sterilizing utensils, adequate water heating facilities, hand washing facilities, and room and equipment kept clean. Country butter shall be labeled or marked in compliance with regulations on Labeling and Marking.

Cheese is the product made from the separated curd obtained by coagulating the casein of milk, skimmed milk, or milk enriched with cream. The coagulation may be accomplished (1) by means of rennet or other suitable enzyme, (2) by lactic fermentation, or by a combination of the two. The curd may be modified by heat, pressure, ripening ferments, special molds, or suitable seasoning. Certain varieties of cheese are made from the milk of animals other than the cow. These regulations apply to all cheese made from the milk of any animal, but where milk of animals other than the cow is used, the cheese shall be so labeled unless it is a variety of cheese made only from the milk of a certain animal and that fact is known and accepted by the consuming public. Any cheese defined in these regulations may contain added harmless food coloring. The name "Cheese" unqualified, means Cheddar Cheese (American Cheese, American Cheddar Cheese).

Cheddar Cheese, American Cheese, American Cheddar Cheese is cheese made by the Cheddar process from heated and pressed curd obtained by the action of rennet on milk. It contains not more than thirty-nine (39%) percent of water, and in the water-free substance, not less than fifty (50%) percent of milk fat. Cheddar Cheese obtains its name from a special cutting and handling process.

Cream Cheese is the unripened cheese made from whole milk enriched with cream. It contains, in the water-free substance, not less than sixty-five (65%) percent of milk fat. After the milk has coagulated the whole is dumped upon a rack to drain, and the curd frequently stirred to facilitate removal of the whey. Salt is added to taste.

Cottage Cheese is the unripened cheese made from heated or unheated, separated curd obtained by the action of lactic fermentation or rennet, or a combination of the two, or skimmed milk with or without the addition of butter-milk. The drained curd may be enriched with cream and salted or otherwise seasoned. Cottage cheese of the best texture contains 70 to 75% of moisture.

Pasteurized Cheese - Pasteurized Blended Cheese is the pasteurized cheese product made by comminuting and mixing, with the aid of heat and water, one or more lots of cheese into a homogenous, plastic mass. The unqualified name "Pasteurized Cheese", "Pasteurized-blended Cheese" is understood to mean pasteurized Cheddar Cheese, pasteurized-blended Cheddar Cheese, and applies to a product which conforms to the standard of Cheddar Cheese. Pasteurized cheese, pasteurized-blended cheese, bearing a varietal name, is made from cheese of the variety indicated by the name and conforms to the limits for fat and moisture for cheese of that variety.

Process Cheese is the modified cheese made by comminuting and mixing one or more lots of cheese into a homogenous plastic mass, with the aid of heat, with or without the addition of water, and with the incorporation of not more than three (3%) percent of a suitable emulsifying agent. The name "process cheese" unqualified, is understood to mean Cheddar Cheese,

and applies to a product which contains not more than forty (40%) percent of water, and, in the water-free substance, not less than fifty (50%) percent of milk fat. Process cheese, qualified by a varietal name is made from cheese of the variety indicated by the name and conforms to the limits for fat and moisture for cheese of that variety.

Skimmed Milk Cheese is cheese made from skimmed milk and the finished product contains less than fifty (50%) percent of butterfat based on the moisture free substance or contains more than thirty-nine (39%) percent moisture.

Special Cheeses. There are a number of varietal cheeses on the market with names fixed by trade custom, by special processes of manufacture, or by location of manufacture. The use of such names on cheese, unless processed or manufactured according to special trade custom, process of manufacture, or location of manufacture, is prohibited. The following definitions shall apply to the Special Cheeses:

Stilton Cheese is cheese made by the Stilton process from unpressed curd obtained by the action of rennet on whole milk, with or without added cream, and which otherwise conforms to the definition of cheese. During the ripening process a special blue-green mold develops and the cheese thus acquires a marbled or mottled appearance in section.

Neufchatel Cheese is cheese made by the Neufchatel process from unheated curd obtained by the combined action of lactic fermentation and rennet on whole milk. The curd, drained by gravity and light pressure, is kneaded or worked into a butterline consistency and pressed into forms for immediate consumption or for ripening; and which otherwise conforms to the definition of cheese. The finished cheese contains, in the water-free substance, not less than fifty (50%) percent of milk fat.

Roquefort Cheese is cheese made by the Roquefort process from unheated, unpressed curd obtained by the action of rennet on the whole milk of sheep, with or without the addition of a small proportion of the milk of goats, and which otherwise conforms to the definition of cheese. The curd is inoculated with a special mold (Penicillium roqueforti) and ripens with the growth of the mold. The fully ripened cheese is friable and has a mottled or marbled appearance in section.

Gorgonzola Cheese is cheese made by the Gorgonzola process from curd obtained by the action of rennet on whole milk and which otherwise conforms to the definition of cheese. The cheese is ripened in a cool, moist atmosphere conducive to the development of an inoculated blue-green mold and thus acquires a mottled or marbled appearance in section.

Edam Cheese is cheese made by the Edam process from heated and pressed curd obtained by the action of rennet on whole milk or on partly skimmed milk and which otherwise conforms to the definition of cheese. It is commonly made in spherical form and coated with a suitable oil and harmless red food coloring.

Swiss Cheese is cheese made by the Emerthaler process from heated and pressed curd obtained by the action of rennet on whole milk or on partly skimmed milk. It is inoculated with special gas-producing bacteria which, as the cheese ripens, causes the formation of "eyes" or holes. The finished cheese contains, in the water-free substance, not less than forty-five (45%) percent of milk fat, and which otherwise conforms to the definition of cheese.

Camembert Cheese is cheese made by the Camembert process from unheated, unpressed curd obtained by the action of rennet on whole milk or on a slightly skimmed milk. As it ripens, there is a growth of special mold (Penicillium camemberti) develops on the outer surface. The finished cheese contains, in the water-free substance, not less than forty-five (45%) percent of milk fat, and which otherwise conforms to the definition of cheese.

Limburger Cheese is cheese made by the Limburger process from unpressed curd obtained by the action of rennet on whole milk. The curd is ripened in a damp atmosphere by a special fermentation process. The finished cheese contains, in the water-free substance not less than fifty (50%) percent of milk fat and which otherwise conforms to the definition of cheese.

Casein is that solid or semi-solid material obtained from skimmed milk or buttermilk by precipitation of the milk solids by the addition of acids or whey. The casein may be subsequently washed, ground and dried.

Whey is the liquid or semi-liquid material remaining after the removal of fat and casein from milk or cream in the process of cheese making.

Sour Cream. Same as cream and sour cream in milk regulations.

Sweet Cream for manufacturing butter, shall consist of fresh, clean cream of good flavor, the acidity of which does not exceed two-tenths (.2%) of one percent, expressed as lactic acid.

Condensed Milk, Evaporated Milk or Concentrated Milk is the food product obtained by the evaporation of a considerable portion of the water from whole, fresh, clean milk, and contains, all tolerances being allowed for, not less than twenty-five and five-tenths (25.5%) percent of total milk solids and not less than seven and nine-tenths (7.9%) percent of milk fat.

Sweetened Condensed Milk, Sweetened Evaporated Milk or Sweetened Concentrated Milk is the food product obtained by the evaporation of a considerable portion of the water from whole, fresh, clean milk, to which sugar (sucrose) has been added. It contains, all tolerances being allowed for, not less than twenty-eight (28%) percent of total milk solids, and not less than eight (8%) percent of milk fat.

Condensed Skimmed Milk, Evaporated Skimmed Milk, Concentrated Skimmed Milk is the food product obtained by the evaporation of a considerable portion of the water from fresh clean skimmed milk, and contains all tolerances being allowed for, not less than twenty (20%) percent of total milk solids.

Sweetened Condensed Skimmed Milk, Sweetened Evaporated Skimmed Milk, Sweetened Concentrated Skimmed Milk is the food product obtained by the evaporation of a considerable portion of the water from fresh clean skimmed milk to which sugar (sucrose) has been added. It contains, all tolerances being allowed for, not less than twenty-eight (28%) percent of total milk solids.

Dried Whole Milk or Powdered Whole Milk is the food product obtained by the removal of water from whole fresh, clean milk. It contains not less than twenty-six (26%) percent of milk fat, and not more than five (5%) percent of moisture.

Dried Skimmed Milk or Powdered Skimmed Milk is the food product obtained by the removal of water from fresh, clean skimmed milk. It contains not more than five (5%) percent of moisture.

Filled Milk or Imitation Milk means any milk or milk products or any combination of milk, cream, or skimmed milk products in which some fat or oil, other than milk fat, has been substituted for the natural butterfat of the milk, thus producing a product which resembles milk or milk products. Provided, that this definition shall not include any distinctive proprietary food compound not readily mistaken for milk or cream or for condensed, evaporated concentrated, powdered, dried or desiccated milk or cream, provided such compound (1) is prepared and designed for the feeding of infants or young children, sick or infirm persons, and customarily used on the order of a physician (2) is packed in individual containers bearing a label in bold type that the contents are to be used for said purposes, and, Provided further, that nothing in this definition shall be held or construed to prevent the use, blending or compounding of chocolate as a flavor with milk, cream or skimmed milk to which or with which has been added, blended or compounded no other fats or oils.

Butter Plant or Creamery shall mean any place where milk, cream or milk products may be received or purchased for the manufacture of butter.

Cheese Plant or Factory shall mean any place where milk, cream or milk products may be received or purchased for the manufacture of cheese.

Milk Plants, Milk Products Plants, Milk Concentration Plants and Cream Stations shall mean any place where cream, milk or milk products may be received, cooled, skimmed or purchased for manufacture or held for shipment or delivery to a butter or cheese products plant, for the manufacture of butter, cheese, condensed milk, evaporated milk, concentrated milk, sweetened condensed milk, sweetened evaporated milk, sweetened concentrated milk, condensed skimmed milk, evaporated skimmed milk, concentrated skimmed milk, sweetened condensed skimmed milk, sweetened evaporated skimmed milk, or sweetened concentrated skimmed milk or filled milk.

Labeling and Marking. All packages and other containers enclosing cheese, butter or other milk products as defined in these regulations shall be plainly labeled or marked with (1) the quantity of contents in terms of weight measure or numerical count (2) the name of the contents as given in the definitions in these regulations (3) the name and address of the producer, seller, distributor, or manufacturer (4) the word "pasteurized" may be used only if the contents have been pasteurized and the word "raw" may be used only if the contents are raw and the name of the plant at which the contents were pasteurized if the contents are pasteurized. The label or mark shall be in letters of a size, kind, and color approved by the health officer having jurisdiction and shall contain no marks or words which are misleading. All filled milk and imitation milk shall be labeled as such.
Butter and cheese when sold at retail shall be labeled with the name of the manufacturer,

together with the net weight.
Renovated or process butter shall comply with all the provisions for labeling butter and in addition shall carry the words "Renovated Butter" or "processed butter" displayed in bold faced type in such a way that these words are equally as large, legible and readable as any other portion of the label.
Country butter shall comply with all the provisions for labeling butter and in addition shall carry the words "Pasteurized Country Butter", if the product has been pasteurized, or the words "Raw County Butter", if the product has been manufactured from raw milk or cream. The words shall be displayed in bold face type in such a way that these words are equally large, legible and readable as any other portion of the label.
All package cheese sold must be labeled to indicate the variety.
It shall be unlawful to manufacture or expose for sale any "part skim milk cheese", or "skim milk cheese" except cottage cheese, unless every vessel, can, package, cheese, or piece of cheese so exposed, or sold is legibly and conspicuously labeled with the words "part skim milk cheese" or "skim milk cheese" as the case may be and any place or establishment where "part skim milk" or "skim milk cheese" is sold at retail shall display a conspicuous legible sign containing the words "part skim milk cheese sold here" or "skim milk cheese sold here" in plain, block letters, not less than six inches high and also the guaranteed maximum moisture and minimum fat contents of such cheese in plain, block letters, not less than one inch high. The Sanitary and Legal aspects of control of butter, cheese and other milk products are the same as that for milk.

FROZEN DESSERTS

The following is taken from the United States Public Health Service Frozen Desserts Code:

A. Definitions. The following definitions shall apply in the interpretation and the enforcement of this ordinance:

1. Frozen Desserts. A frozen dessert is any clean frozen or partially frozen combination of two or more of the following: Milk or milk products, eggs or egg products, sugars, water, fruit or fruit juices, candy, nut meats, or other harmless and wholesome food products, flavors, color, or harmless stabilizer, and shall be deemed to include ice cream, frozen custard, ice milk, milk sherbet, ices, and other similar products.

2. Milk and Milk Products. Milk and milk products used in mix or frozen desserts shall include milk, cream, frozen cream, plastic cream, fluid skim milk, butter, sweetened and unsweetened evaporated milk, sweetened and unsweetened evaporated skim milk, sweetened and unsweetened condensed milk, sweetened and unsweetened condensed skim milk, powdered whole milk, powdered skim milk, sweet cream buttermilk, sweet cream condensed buttermilk, and sweet cream powdered buttermilk, or any of these products from which lactose has been wholly or partially removed.

3. Mix. Mix is the unfrozen combination of all ingredients of a frozen dessert with or without fruits, fruit juices, candy, nut meats, flavor, or harmless color.

4. Pasteurization. The terms "pasteurization", "pasteurized", and similar terms shall be taken to refer to the process of heating every particle of mix to at least 155°F. and holding at such temperature for at least 30 minutes in approved and properly operated equipment: Provided, that nothing contained in this definition shall be construed as disbarring any other process which has been demonstrated to be equally efficient and is approved by the State Health Authority.

5. Frozen Desserts Manufacturer. A frozen desserts manufacturer is any person who manufactures, processes, or freezes any mix or frozen desserts for distribution or sale.

6. Frozen Desserts Plant. A frozen desserts plant is hereby defined as any place or premises where frozen desserts or mix are manufactured, processed, or frozen for distribution or sale.

7. Milk Products Plant. A milk products plant shall mean any place or premises where milk or milk products are skimmed, condensed, evaporated, powdered, manufactured into butter, or otherwise processed for subsequent manufacture of mix or frozen desserts.

8. Receiving Station. A receiving station shall mean any place or premises where milk or milk products are received for subsequent delivery to milk products plants or frozen desserts plants.

9. Average Bacterial Plate Count, Direct Microscopic Count, Reduction Time, and Cooling Temperature. Average bacterial plate count and average direct microscopic count shall be taken to mean the logarithmic average, and average reduction time and average cooling temperature shall be taken to mean the arithmetic average, of the respective

results of the last four consecutive samples, taken upon separate days (irrespective of the date of grading or regrading).

10. Adulterated or Misbranded Frozen Desserts or Mix. Any frozen dessert or mix which contains any unwholesome substance, or which if defined in this ordinance does not conform with its definition, (or which carries a grade label unless such grade label has been awarded by the health officer and not revoked,) shall be deemed adulterated and/or misbranded.

11. Grading Period. The grading period shall be taken to mean the interval between the public announcements of the grades of frozen desserts plants and shall in no case exceed 6 months.

B. The Sale Prohibited of Mix or Frozen Dessert Which is Adulterated or Misbranded. No person shall, within the municipality or its police jurisdiction, manufacture, freeze, sell, or offer or expose for sale, or have in possession with intent to sell, any mix or frozen dessert which is adulterated or misbranded.

C. Permits. It shall be unlawful for any person to deliver directly or indirectly into or receive into the municipality or its police jurisdiction for sale, or to produce, sell or offer for sale therein, or to have in storage where mix or frozen desserts are sold or served, any mix or frozen dessert, who does not possess a permit from the health officer. Only a person who complies with the requirements of this ordinance shall be entitled to receive and retain such a permit. Such a permit may be suspended by the health officer, or revoked after an opportunity for a hearing by the health officer, upon the violation by the holder of any of the terms of this ordinance.

D. Labeling (and placarding) . All cans, packages, and other containers enclosing mix or frozen desserts or their ingredients derived from milk, except those filled from labeled bulk containers in retail dispensing, shall be plainly labeled or marked with (1) the name of the contents; (2) in the case of mix the word "pasteurized" if the contents have been pasteurized; and (3) the name and the street address, or the permit number, of the plant at which the contents were placed in the container. A descriptive word or phrase indicating in more detail the composition or flavoring of the mix or frozen dessert, such as strawberry, chocolate, custard, lemon, etc., may be used on the label. The label or mark shall be in letters of a size, kind, and color approved by the health officer. Trad[e] names and trade marks may be permitted. The label shall contain no marks or words which are misleading. No person who manufactures, distributes, or dispenses frozen desserts or mix may display any grade placard, sign, or notice without the approval of the health officer.

E. Inspection of Frozen Desserts Plants. At least once during each grading period the health officer shall inspect all frozen desserts plants the products of which are intended for consumption within the municipality or its police jurisdiction. In case the health officer discovers the violation of any item of sanitation, he shall make a second inspection after a lapse of such time as he deems necessary for the defect to be remedied, but not before the lapse of 3 days, and the second inspection shall be used in determining compliance with the grade requirements of this ordinance. Any violation of the same item of this ordinance on two consecutive inspections shall call for immediate degrading or suspension of permit. One copy of the inspection report shall be delivered to the owner of the premises inspected, or his agent, and shall be readily available at any time for a period of 12 months. Another copy of the inspection report shall be filed with the records of the health department.

F. The Examination of Frozen Desserts and Their Ingredients. During each grading period at least four samples of frozen desserts and pasteurized mix from each plant shall be tested by the health officer. Samples of mix or frozen desserts may be taken by the health offi cert at any time prior to final delivery. Samples of ingredients may be tested as often as the health officer may require. Samples of frozen desserts from stores, cafes, soda fountains, restaurants, and other places where frozen desserts are sold may be tested as often as the health officer may required. Bacterial plate counts and direct microscopic counts shall be made in conformity with the 1934 standard methods recommended by the American Public Health Association. Examination may include such other chemical and physical determinations as the health office may deem necessary for the detection of adulteration, these examinations to be made in conformity with the 1934 standard methods of the American Public Health Association and the Association of Official Agricultural Chemists. All proprietors of plants, stores, cafes, restaurants, soda fountains, and other similar places shall furnish the health officer, upon his request, with the names of all persons from whom their mix or frozen desserts are obtained. Whenever the avera[ge] bacterial count, the average reduction time, or the average cooling temperature falls

beyond the limit (for the grade then held), the health officer shall send written notice thereof to the plant concerned, and shall take an additional sample, but not before the lapse of three days, for determining a new average. Violation of the (grade) requirement by the new average or by any subsequent average during the remainder of the current grading period shall call for immediate degrading or suspension of the permit, unless the last individual result is within the grade limit.

G. The Grading of Frozen Desserts Plants. At least once every 6 months the health officer shall announce the grades of all frozen desserts plants the products of which are ultimately consumed within the municipality or its police jurisdiction. Said grades shall be based upon the following standards.

Sanitation Requirements for Grade A Frozen Desserts Plants. All grade A frozen desserts plants shall comply with the following items of sanitation.

1. Floors. The floors of all rooms in which mix, frozen desserts, or their ingredients are manufactured, frozen, or stored, or in which containers and utensils are washed, shall be constructed of concrete or other equally impervious and easily cleaned material, and shall be smooth, properly drained, provided with trapped drains, and kept clean; Provided, that cold storage rooms need not be provided with drains; Provided further, that the construction requirements of this item shall be waived, in frozen desserts plants which freeze and sell only at retail on the premises, if the portion of the room in which the freezer is installed and the room in which containers or utensils are washed have impervious floors or solid floors covered with tight linoleum or other approved, washable material.

2. Walls and Ceilings. Walls and ceilings or rooms in which mix, frozen desserts, or their ingredients are manufactured or frozen, or in which containers or utensils are washed, shall have a smooth, washable, light-colored surface, and shall be kept clean.

3. Doors and Windows. Unless other effective means are provided to prevent the access of flies, all openings to the outer air shall be effectively screened and doors shall be self-closing.

4. Lighting and Ventilation. All rooms shall be well lighted and ventilated.

5. Miscellaneous Protection from Contamination. The various plant operations shall be so located and conducted as to prevent any contamination of the mix, frozen desserts, their ingredients, cleaned equipment, or containers. All means necessary for the elimination of flies shall be used.

   Separate rooms shall be provided for (a) the pasteurizing, processing, cooling, freezing, and packaging operations, and (b) the washing and bactericidal treatment of containers: Provided, that requirements (a) shall be satisfied, in frozen desserts plants which freeze and sell only at retail on the premises, if all mixing, freezing, and packaging processes, but not necessarily the hardening and storage compartments, are enclosed in a tight glass or other sanitary enclosure which is open only on the side farthest from the public, which has a dust-tight top extending over the entire freezer, and which is protected by a fan so installed and of such power as to prevent the entrance of flies. Containers of frozen desserts ingredients shall not be unloaded directly into the room or rooms used for pasteurization or subsequent processes. Pasteurized mix or frozen desserts shall not be permitted to come in contact with equipment with which unpasteurized mix, frozen desserts, milk, or milk products have been in contact, (or with which mix or frozen desserts from a lower grade plant have been in contact,) unless such equipment has first been thoroughly cleaned and subjected to bactericidal treatment. None of the operations connected with a frozen desserts plant shall be conducted in a room used for domestic purposes.

6. Toilet Facilities. There shall be provided toilet facilities conforming with the ordinances of the municipality and which are kept clean, well ventilated, and in good repair. Toilet rooms shall not open directly into any room in which frozen desserts, their ingredients, equipment, or containers are handled or stored. The doors of all toilet rooms shall be self-closing. In case privies or earth closets are permitted and used, they shall be separate from the building, and shall be of a sanitary type constructed and operated in conformity with the requirements of the State Board of Health.

7. Water Supply. The water supply shall be easily accessible, adequate, and of a safe, sanitary quality.

8. Hand-washing Facilities. Convenient hand-washing facilities shall be provided, including warm running water, soap, and approved sanitary towels. The use of a common towel is prohibited. No employee shall resume work after using the toilet room without first washing his hands.

9. Sanitary Piping. All piping used to conduct ingredients, mix, or frozen desserts shall be "sanitary milk piping" of a type which can be easily cleaned with a brush.

10. Construction and Repair of Containers and Equipment. All multi-use containers and equipment with which mix, frozen desserts, or their ingredients come in contact shall be constructed in such manner as to be easily cleaned, and shall be kept in good repair.

11. Disposal of Wastes. All wastes shall be properly disposed of.

12. Cleaning and Bactericidal Treatment of Containers and Equipment. All multi-service containers and equipment for mix, frozen desserts, or their ingredients shall be thoroughly cleaned after each usage. All containers shall be subjected to an approved bactericidal process after each cleaning, and all equipment immediately before each usage. When empty and before being returned by a frozen desserts plant, each milk and milk products container shall be effectively cleaned and subjected to bactericidal treatment.

13. Storage of Containers. After bactericidal treatment all multi-use containers for mix, frozen desserts, and their ingredients shall be stored in such manner as to be protected from contamination.

14. Handling of Containers and Equipment. Between bactericidal treatment and usage, and during usage, containers and equipment shall not be handled or operated in such manner as to permit contamination of the frozen desserts, mix, or their ingredients.

15. Storage and Handling of Single-Service Containers and Utensils. Caps, parchment papers, wrappers, can liners, and single-service sticks, spoons, and containers for frozen desserts, mix, or their ingredients shall be purchased only in sanitary containers, shall be kept therein in a clean dry place, and shall be handled in a sanitary manner.

16. Pasteurization of Mix. All mix shall be pasteurized as described in definition of pasteurization of this ordinance.

17. Cooling and Handling. All milk and fluid milk products received at the frozen desserts plant for use in frozen desserts or mix shall immediately be cooled in approved equipment to 50°F. or less and maintained at that temperature until pasteurized, unless they are to be pasteurized within 2 hours after receipt; and all pasteurized mix shall immediately be cooled in approved equipment to an average temperature of 50°F. or less, as defined in this ordinance, and maintained thereat until frozen. All mix which is not frozen at the plant at which it was pasteurized shall be transported to the place of manufacturing or freezing in sealed containers, and the mix shall be handled in a sanitary manner. Dipping from containers of pasteurized mix is prohibited.

18. Packaging. Packaging, cutting, molding, dipping, and other preparation of mix or frozen desserts or their ingredients shall be done in an approved manner. Containers shall be adequately covered immediately after filling. Caps or covers shall be handled in such manner as to prevent contamination of the package contents.

19. Overflow or Spillage. Product drip, or overflow or spilled mix or frozen desserts or their ingredients, shall not be sold for human consumption.

20. Returns. Mix or frozen desserts in broken and open containers may after delivery be returned to the plant for inspection, but shall not be used for making mix or frozen desserts.

21. Personnel, Health. The health officer or a physician authorized by him shall examine and take a careful morbidity history of every person connected with a frozen desserts plant, or about to be employed, whose work brings him in contact with the production, handling, or storage of mix or frozen desserts, containers, or equipment. If such examination suggests that such person may be a carrier of or infected with the organisms of typhoid or paratyphoid fever or any other communicable diseases likely to be transmitted through frozen desserts, he shall secure appropriate specimens of body discharges and cause them to be examined in a laboratory

approved by him or by the State Health authorities for such examinations, and if the results justify such person shall be barred from such employment. Such persons shall furnish such information, submit to such physical examinations, and submit such laboratory specimens as the health officer may require for the purpose of determining freedom from infection.

22. Personnel, Cleanliness. All persons coming in contact with mix, frozen desserts, their ingredients, containers, or equipment shall wear clean outer garments and shall keep their hands clean at all times while thus engaged.

23. Miscellaneous. All vehicles used for the transportation of mix or frozen desserts or their ingredients shall be so constructed and operated as to protect their contents from the sun and from contamination. Such vehicles shall be kept clean, and no substance capable of contaminating mix or frozen desserts or their ingredients shall be transported therewith in such manner as to permit contamination. All vehicles used for the distribution of mix or frozen desserts shall have the name of the distributor prominently displayed.

24. Bacterial Plate Count of Pasteurized Mix or Frozen Desserts. The average bacterial plate count of the pasteurized mix or the frozen desserts shall at no time prior to delivery exceed 50,000 per gram.

25. Ingredients. All mix and frozen desserts ingredients shall be clean, have a fresh wholesome flavor and odor and a normal appearance, be of satisfactory quality, and shall be handled or processed in an approved manner.

Milk and milk products used as ingredients in the raw state shall have an average bacterial plate count not exceeding 200,000 per cubic centimeter or per gram, or an average direct microscopic count not exceeding 200,000 per cubic centimeter or per gram if clumps are counted or 800,000 if individual organisms are counted, or an average reduction time of not less than 6 hours, and milk and milk products used as ingredients in the pasteurized, condensed, evaporated, or dried state shall have an average bacterial plate count not exceeding 50,000 per cubic centimeter or per gram: Provided, that these limits shall be doubled in the case of cream.

Grade B Frozen Desserts Plants. Grade B frozen desserts plants are those which conform with all on the requirements for grade A plants except as follows:
In Item 1 floors may be of tight wood or linoleum surfacing instead of concrete, tile, etc., if they are smooth and kept clean; and floor drains are not required.
In Item 2 the requirements relative to the surfaces of walls and ceilings shall be waived if they are kept clean.
In Item 4 the ventilation requirement and the requirement relative to the even distribution of light shall be waived.
In Item 24 the average bacterial plate count of the pasteurized mix or the frozen desserts shall at no time prior to delivery exceed 100,000 per gram.
In Item 25 milk and milk products used as ingredients in the raw state shall have an average bacterial plate count not exceeding 1,000,000 per cubic centimeter or per gram, or an average direct microscopic count not exceeding 1,000,000 per cubic centimeter or per gram if clumps are counted or 4,000,000 if individual organisms are counted, or an average reduction time of not less than 3½ hours; and milk and milk products used as ingredients in the pasteurized, condensed, evaporated, or dried state shall have an average bacterial plate count not exceeding 250,000 per cubic centimeter or per gram: Provided, that these limits shall be doubled in the case of cream.

Grade C Frozen Desserts Plants. Grade C frozen desserts plants are those which violate any of the requirements for grade B plants.

H. Grades of Frozen Desserts Plants which may Sell their Products. From and after 12 months from the date on which this ordinance takes effect no mix or frozen desserts shall be sold for ultimate consumption unless it has been manufactured and frozen in a plant conforming with the grade A or grade B requirements of this ordinance: Provided, that when any frozen desserts plant fails to qualify for grade A or grade B the health officer is authorized to revoke the permit or in lieu thereof to degrade the plant and permit its operation during a temporary period of 30 days.

I. Suspension and Reissuing of Permit; Supplementary Regrading. If at any time (between regular announcements of the grades of frozen desserts plants a lower grade or) a suspension of the permit shall become justified in any case, the health officer shall, subject to the provisions of this ordinance, immediately (lower the grade or) suspend the

permit of said frozen desserts plant. Any frozen desserts plant (the grade of which has been lowered and all grade displays, if any, have been changed accordingly, or) the permit of which has been suspended by the health officer may at any time make application for (regrading or) the reissuing of the permit.

Upon receipt of a satisfactory application, in case the (lowered grade or) the suspension of permit is the result of an unsatisfactory bacterial condition or cooling temperature, the health officer shall take further samples at the rate of not more than two samples per week. The health officer shall (regrade the applicant upward or) reissue the permit whenever the average of the last four sample results indicates the necessary compliance.

In case the lowered grade or the suspension of permit is due to the violation of any item or items of the specifications prescribed other than bacterial condition or cooling temperature, the said application must be accompanied by a statement signed by the applicant to the effect that the violated item or items of the specifications have been conformed with. Within one week of the receipt of such an application and statement the health officer shall make a reinspection, and thereafter as many additional reinspections as he may deem necessary to assure himself that the applicant is again complying with the higher grade requirements, and, in case the findings indicate compliance, shall award the higher grade or reissue the permit.

J. Transferring and Dispersing Frozen Desserts. No person shall transfer frozen desserts from one container to another or package the same on the street or in any vehicle or in any place except a sanitary room under approved conditions.

K. Mix and Frozen Desserts from Points beyond the Limits of Routine Inspection. Mix and frozen desserts from points beyond the limits of routine inspection of the municipality may not be sold in the municipality or its police jurisdiction, unless controlled under provisions equivalent to the requirements of this ordinance: Provided, that the health officer shall satisfy himself that the health officer having jurisdiction over the manufacture is properly enforcing such provisions.

L. Future Frozen Desserts Plants. All frozen desserts plants from which mix or frozen desserts are supplied to the municipality which are hereafter constructed, reconstructed, or extensively altered, shall conform in their construction to the grade A requirements of this ordinance. Properly prepared plans for all frozen desserts plants which are hereafter constructed, reconstructed, or extensively altered shall be submitted for approval before work is begun, and signed approval shall be obtained from the health officer and/or the State Health Department.

M. Procedure when Infection Suspected. When suspicion arises as to the possibility of transmission of infection from any person concerned with the handling of mix, frozen desserts, or their ingredients, the health officer is authorized to require any or all of the following measures: (1) the immediate exclusion of that person from handling mix, frozen desserts, or their ingredients; (2) the immediate exclusion of the supply concerned from distribution and use; (3) adequate medical and bacteriological examination of the person, of his associates, and of his and their body discharges.

N. Notification of Disease. Notice shall be sent to the health officer immediately by any frozen desserts manufacturer or distributor among whose employees any infectious, contagious, or communicable disease occurs.

FROZEN DESSERTS: REGULATIONS OF THE LOUISIANA SANITARY CODE

The sanitary provisions (including bacterial) of the Frozen Dessert regulations of Louisiana are almost wholly adopted from the regulations recommended by the United States Public Health Service. Definitions of the various types of frozen desserts are characterized by specifications of the Louisiana State Department of Health. Adulteration, misbranding, labelling, permits, sampling, and so on, are regulated in accordance with the Louisiana Food, Drug and Cosmetic Act.

Definitions. The following definitions shall apply in the interpretation and the enforcement of these regulations.

Frozen Desserts. A frozen dessert is any clean frozen or partially frozen combination of two or more of the following: milk or milk products, eggs or egg products, sugars, water, fruit or fruit juices, candy, nut meats, or other harmless and wholesome food products, flavors, color, or harmless stabilizer, and shall be deemed to include ice cream, fruit ice cream, nut ice cream, ice cream mix, frozen custard, ice milk, milk sherbert, ices or ice sherberts, frozen malt or frosted malt, imitation ice cream and other similar products.

The following optional saccharine ingredients may be used in the manufacture of frozen desserts: (1) sugar, (2) dextrose, (3) invert sugar syrup, (4) corn syrup, dried corn syrup, (5) maple syrup, maple sugar, (6) honey, (7) brown sugar and (8) molasses. The use of saccharin is prohibited.

Ice Cream. Is the clean, frozen dessert product made from a combination of two or more of the following ingredients: milk or milk products, eggs, egg products, water and sugar with harmless flavoring and with or without harmless coloring, and with or without added stabilizer. It shall contain not less than ten (10%) percent milk fat and not less than twenty (20%) percent total milk solids, nor more than one (1%) percent of harmless fillers or binders, except that when ingredients of ice cream include eggs, fruit or fruit juices, cake, confection, cocoa or chocolate, or nuts, used for the purpose of flavoring, such reduction of the percentage of milk fat and milk solids not fat as may be due to the addition of such ingredient shall be allowed. The finished ice cream shall contain not less than 1.6 pounds of total food solids to the gallon, and shall weigh not less than 4.5 pounds per gallon.

Fruit Ice Cream. Is a frozen dessert product made from the constituent parts of milk or milk products, and with or without the addition of sugars, harmless binders or flavorings, and sound, clean, mature fruits, and fruit juices, and shall contain not less than eight (8%) percent butter fat, nor less than eighteen (18%) percent total milk solids, nor more than one (1%) percent harmless fillers and binders. The finished product shall in no case contain less than 1.6 pounds of total food solids to the gallon, and shall weigh not less than 4.5 pounds per gallon.

Nut Ice Cream. Is a frozen dessert product made from the constituent parts of milk or milk products, and with or without the addition of sugars, harmless fillers and binders, or flavorings and sound, clean, non-rancid nut meats, and shall contain not less than eight (8%) percent butter fat, nor less than eighteen (18%) percent total milk solids, nor more than one (1%) percent of harmless filler or binder. The finished product shall in no case contain less than 1.6 pounds of total food solids to the gallon and shall weigh not less than 4.5 pounds per gallon.

Ice Cream Mix. Is the unfrozen product which results from the mixture of pure clean dairy products, sugar and other products allowed in the manufacture of ice cream, with or without harmless flavoring and coloring. In no case shall ice cream mix contain less than ten (10%) percent by weight of milk fat, and not less than twenty (20%) percent by weight of total milk solids; except when fruits, nuts, cocoa or chocolate, cake or confections, are used for the purpose of flavoring, it shall contain not less than eight (8%) percent by weight of milk fat and not less than eighteen (18%) percent by weight of total milk solids.

Frozen Custard. Is French ice cream, French custard ice cream, ice custard, parfaits and similar frozen dessert products. Frozen custard is a clean, wholesome, frozen dessert made from a cooked combination of two or more of the following ingredients: Milk or milk products, eggs, water and sugar, with harmless flavoring and coloring and with or without added harmless stabilizers. It contains not more than one (1%) percent by weight of stabilizer, not less than six (6%) percent by weight of milk fat, and not less than fourteen (14%) percent by weight of total milk solids. Frozen custard shall contain not less than two and one-half dozen of clean, wholesome egg yolks, or three fourths pound of wholesome dry egg yolks, containing not to exceed seven (7%) percent of moisture, or one and one-half pounds of wholesome frozen egg yolk containing not to exceed fifty-five (55%) percent of moisture, or the equivalent of egg yolk in any other form, for each ninety (90) pounds of frozen custard. The finished product shall in no case contain less than 1.6 pounds of total food solids to the gallon and shall weigh not less than 4.5 pounds per gallon.

Ice Milk. Is the clean, frozen dessert product made from a combination of two or more of the following ingredients: Milk or milk products, eggs, water and sugar with harmless coloring and flavoring and with or without added stabilizer composed of harmless material. It contains not more than one (1%) percent by weight of stabilizers, not less than three and one-half (3.5%) percent and not more than ten (10%) percent by weight of milk fat, and not less than fourteen (14%) percent by weight of total milk solids. In no case shall the finished product contain less than 1.3 pounds of total food solids per gallon and shall weigh not less than 4.5 pounds per gallon.

Milk Sherbert. Is the clean frozen dessert product from milk or milk products, water and sugar, with harmless fruit or fruit juice flavoring and with or without coloring, with or without citric acid, and with or without added harmless stabilizers. It contains not less than 3.5% and not more than ten (10%) percent by weight of milk fat. It contains not less than four (4%) percent by weight of milk solids and shall weigh not less than 6 pounds per gallon.

Ices or Ice Sherbert. Is the clean, frozen dessert product made from water and sugar with

harmless fruit or fruit juice flavoring, with or without coloring, with or without milk or milk products, with or without added citric acid, and with or without harmless stabilizers. It contains less than four (4%) percent by weight of milk solids. The finished product shall weigh not less than 6 pounds per gallon.

Frozen Malt or Frosted Malt. Is the clean, semi-frozen, or frozen dessert product made from the combination of milk or milk products, malted milk and one or more of the following ingredients: eggs, sugar, dextrose, and honey, with or without flavoring and coloring and with or without harmless gelatine or vegetable stabilizers; and in the manufacture of which, freezing has been accompanied by agitation of the ingredients. It contains not more than one (1%) percent by weight of harmless gelatin or vegetable stabilizer, nor less than three and one-half (3.5%) percent by weight of milk fat, nor more than ten (10%) percent by weight of total milk solids, and not less than one (1%) percent by weight of malted milk concentrate. The finished product shall weigh not less than 1.3 pounds of total food solids per gallon, and it shall weigh not less than 4.5 pounds per gallon.

Imitation Ice Cream. Is any frozen substance, mixture or compound regardless of name under which it is represented, which is made in imitation or semblance of ice cream, or is prepared or frozen as ice cream is customarily prepared or frozen, and which is not ice cream, frozen custard, ice milk, frozen or frosted malts, milk sherberts, and ices or ice sherberts as defined in these regulations. The sale of imitation ice cream is prohibited.

Milk and Milk Products. Used in any frozen dessert mix or frozen desserts, shall include milk, cream, frozen cream, plastic cream, fluid skim milk, butter, sweetened and unsweetened evaporated milk, sweetened and unsweetened evaporated skim milk, sweetened and unsweetened condensed milk, sweetened and unsweetened condensed skim milk, dry powdered whole milk, dry powdered skim milk, sweet cream buttermilk, sweet cream condensed buttermilk, and dry sweet cream powdered buttermilk, or any of these products from which lactose has been wholly or partially removed.

Pasteurization. The terms "pasteurization", "pasteurized", and similar terms shall be taken to refer to the process of heating every particle of mix to at least 155°F. and holding at such temperature for at least 30 minutes in approved and properly operated equipment: Provided, that nothing contained in this definition shall be construed as disbarring any other process which has been demonstrated to be equally efficient and is approved by the State health authority.

Frozen Desserts Plant. A frozen desserts plant is hereby defined as any place or premises where frozen desserts or ice cream mix are manufactured, processed or frozen for distribution or sale.

Frozen Desserts Manufacturer. A frozen desserts manufacturer is any person who manufactures, mixes, compounds, processes or freezes any frozen dessert mix or frozen desserts for distribution or sale.

Milk Products Plant. A milk products plant shall mean any place or premises where milk or milk products are skimmed, condensed, evaporated, powdered, manufactured into butter, or otherwise processed for subsequent use in the manufacture of mix or frozen desserts.

Receiving Station. A receiving station shall mean any place or premises where milk or milk products are received for subsequent delivery to milk products plants or frozen desserts plant.

Average Bacterial Plate Count, Direct Microscopic Count, Reduction Time and Cooling Temperature. Average bacterial plate count and average direct microscopic count shall be taken to mean the logarithmic average of the respective results of tests of the last four consecutive samples, taken upon separate days, and average reduction time and average cooling temperature shall be taken to mean the arithmetic average of the respective results of tests of the last four consecutive samples, taken upon separate days.

Overflow or Spillage. Overflow or spilled frozen desserts or frozen dessert mix or their ingredients, are those which have come in contact with the floor or with containers or equipment surfaces that have not received bactericidal treatment or have not been safe-guarded after treatment, thus exposing the frozen desserts or frozen dessert mix to contamination.

Labeling. All cans, packages, and other containers enclosing frozen dessert mix or frozen desserts, except those filled from labeled bulk containers in retail dispensing, shall be labeled or marked with (1) the name of the contents; (2) in the case of mix the word "pasteurized" if the contents have been pasteurized, and the word "raw" if the contents have not been pasteurized; and (3) the name and the street address, or the permit number, of the plant at which the contents were placed in the container; (4) a statement of the quantity

of contents in terms of volume, etc. The name of the contents shall include any descriptive word or phrase necessary to indicate the composition or flavoring of the mix or frozen dessert; for example, strawberry, chocolate, custard, lemon, etc. The label or mark shall be in letters of a size, kind and color approved by the health officer. Trade names and trade marks may be permitted. The label shall contain no marks or words which are misleading.

Inspection of Frozen Desserts Plants. At least once every six months or as much oftener as he may deem necessary, the health officer or his authorized representative shall inspect all frozen desserts plants, the products of which are intended for consumption within a municipality, parish or health district. In case the health officer or his authorized representative discovers the violation of any item of sanitation, he shall make a second inspection after a lapse of such time as he deems necessary for the defect to be remedied, but not before the lapse of [illegible] days, and the second inspection shall be used in determining compliance with the requirements of these regulations. Any violation of the same item of these regulations on two consecutive inspections shall call for immediate suspension of permit. One copy of the inspection report shall be delivered to the owner of the premises inspected, or his agent, and shall be readily available at any time for a period of 12 months. Another copy of the inspection report shall be filed with the records of the health department.

Storage and Handling of Single-Service Containers and Utensils. Caps, parchment papers, wrappers, can liners, and single-service sticks, spoons, and containers for frozen desserts, frozen dessert mix, or their ingredients shall be purchased only in sanitary containers, shall be kept therein in a clean, dry place, and shall be handled in a sanitary manner.

Pasteurization of Mix. All frozen dessert mix shall be pasteurized as described in the paragraph on Pasteurization under Definitions.

Cooling and Handling. All milk and fluid milk products received at the frozen desserts plants for use in frozen desserts or frozen dessert mix shall immediately be cooled in approved equipment to 50° F. or less and maintained at that temperature until pasteurized, unless they are to be pasteurized within 2 hours after receipt; and all pasteurized mix shall immediately be cooled in approved equipment to an average temperature of 50°F. or less, as defined in these regulations, and maintained thereat until frozen. All frozen dessert mix which is not frozen at the plant at which it was pasteurized shall be transported to the place of manufacturing or freezing in sealed containers, and the frozen dessert mix shall be handled in a sanitary manner. Dipping from containers of pasteurized mix is prohibited.

Packaging. Packaging, cutting, molding, dipping, and other preparation of frozen dessert mix or frozen desserts or their ingredients shall be done in an approved manner. Containers shall be adequately covered immediately after filling. Caps or covers shall be handled in such manner as to prevent contamination of the package contents.

Overflow or Spillings. Product drip, or overflow or spilled mix or frozen desserts or their ingredients shall not be sold for human consumption.

Returns. Frozen dessert mix or frozen desserts in broken and open containers may after delivery be returned to the plant for inspection, but shall not be re-used for making mix or frozen desserts.

The Examination of Frozen Desserts and Their Ingredients. Samples of frozen dessert mix or frozen desserts may be taken by the health officer or his authorized representative at any time prior to final delivery. Samples of ingredients may be tested as often as the health officer may require. Samples of frozen desserts from stores, cafes, soda fountains, restaurants, and other places where frozen desserts are sold, may be tested as often as the health officer may require. Bacterial plate counts and direct microscopic counts shall be made in conformity with the standard methods recommended by the American Public Health Association. Examination may include such other chemical and physical determinations as the health officer may deem necessary for the detection of adulteration, these examinations to be made in conformity with the standard methods of the American Public Health Association and the Association of Official Agricultural Chemists. All proprietors of plants, stores, cafes, restaurants, soda fountains, and other similar places shall furnish the health officer, upon his request, with the names of all persons from whom their frozen dessert mix or frozen desserts are obtained.

Transferring and Dispensing Frozen Desserts. No person shall transfer frozen desserts from one container or package the same on the street or in any vehicle or in any place except a sanitary room provided for this purpose and approved by the health officer.

Frozen Dessert Mix and Frozen Desserts from Points Beyond the Limits of Routine Inspection. Frozen dessert mix and frozen desserts from points beyond the limits of routine inspection of a municipality, parish or health district may not be sold in the municipality, parish or

health district or its police jurisdiction, unless controlled under provisions equivalent to the requirements of these regulations: Provided, that the health officer shall satisfy himself that the health officer having jurisdiction over the manufacture of frozen desserts is properly enforcing such provisions.

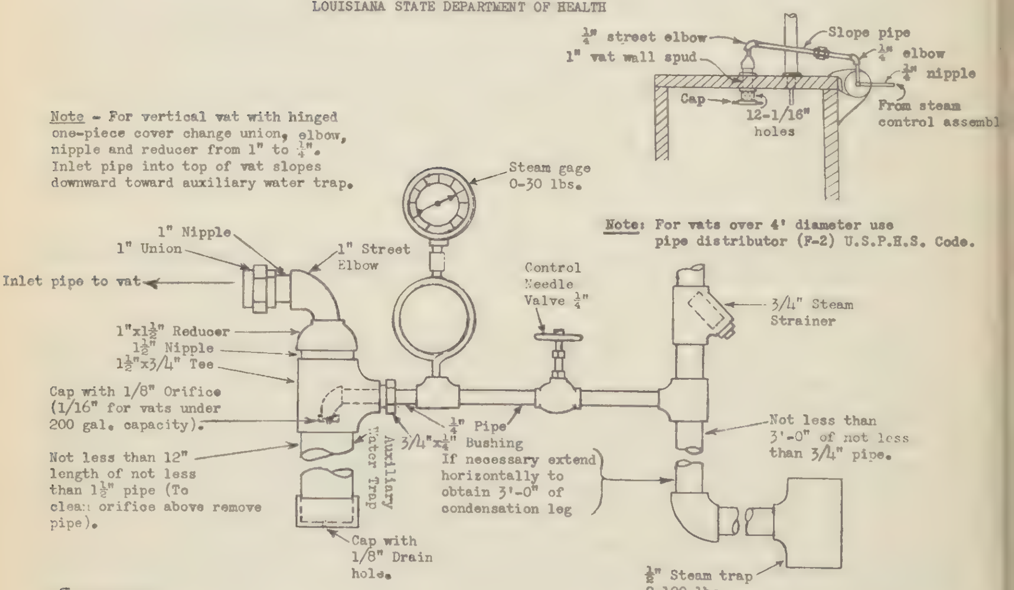
Bacterial Plate Count of Pasteurized Mix or Frozen Desserts. The average bacterial plate count of the pasteurized mix or of frozen desserts shall at no time prior to delivery exceed 50,000 per gram.

Ingredients. All frozen dessert mix and frozen desserts ingredients derived from milk shall be clean, have a fresh wholesome flavor and odor and a normal appearance, be of satisfactory quality, and shall be handled or processed in an approved manner. Milk and milk products used as ingredients in the raw state shall have an average bacterial plate count not exceeding 200,000 per mililiter or per gram or an average direct microscopic count not exceeding 200,000 per mililiter or per gram if clumps are counted or 800,000 per mililiter if individual organisms are counted, or an average reduction time of not less than 6 hours, and milk and milk products used as ingredients in the pasteurized, condensed, evaporated, or dried state shall have an average bacterial plate count not exceeding 50,000 per mililiter or per gram: Provided, that these limits shall be doubled in the case of cream.

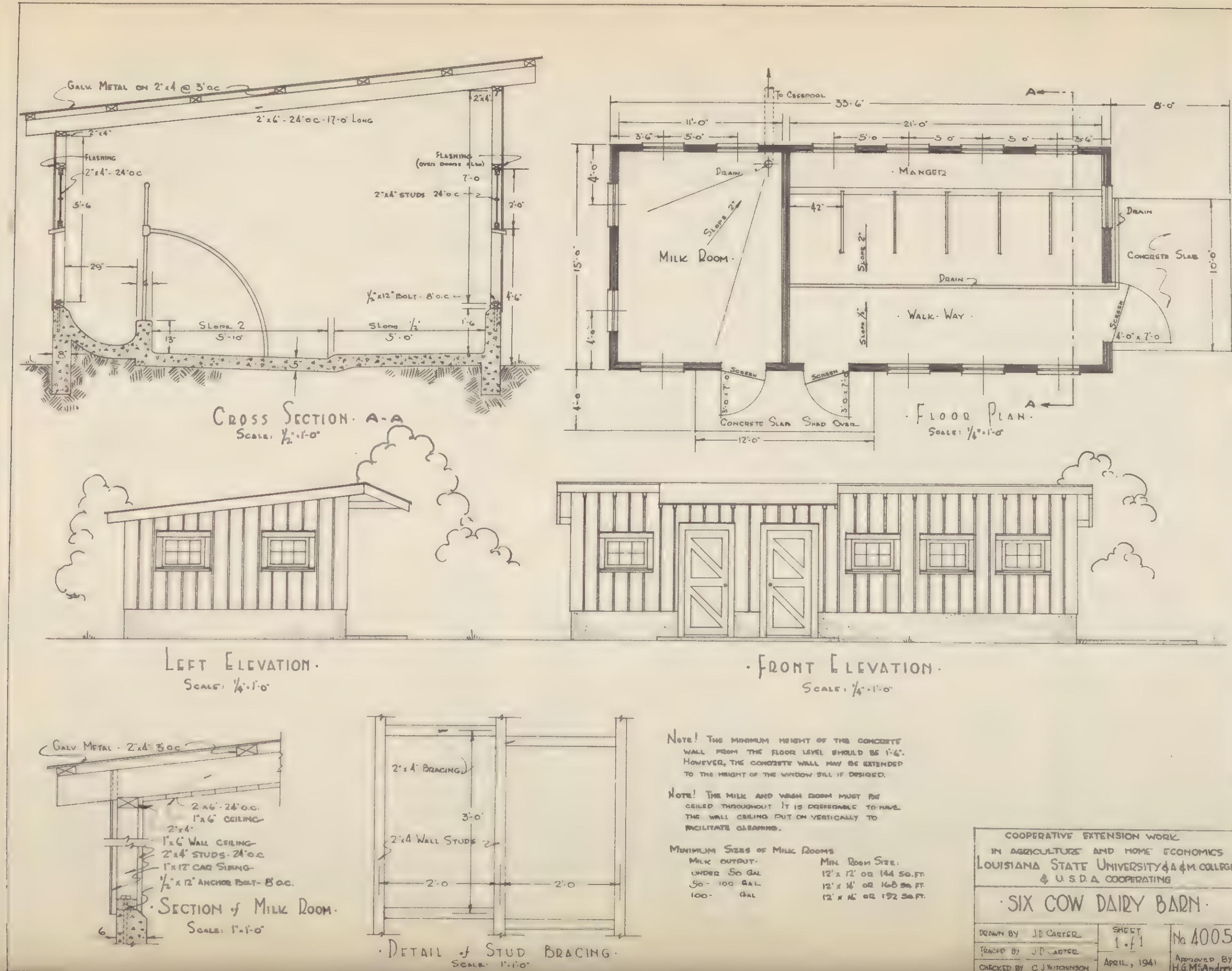
STEAM CONTROL ASSEMBLY

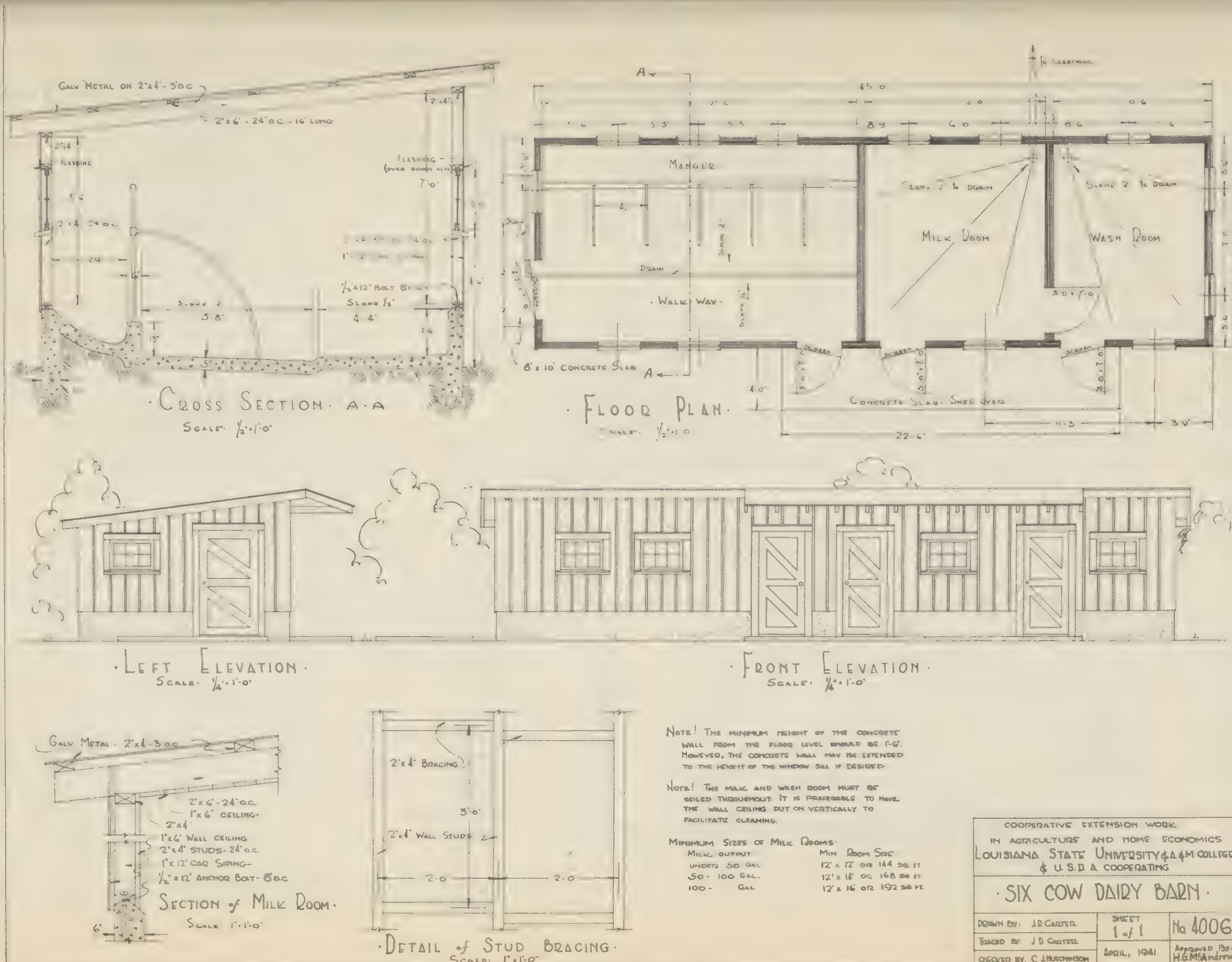
(Uniform for all installations except as noted above)
Taken from 1939 U.S.P.H.S. Code, page 123.

Milk Sanitation Section
Bureau of Public Health Engineering
LOUISIANA STATE DEPARTMENT OF HEALTH



Form Nº 141


Galv. Metal on 2"x4 @ 3' o.c.
2"x6"-24" o.c.-17'-0" Long
2"x4"
Flashing
2"x4"-24" o.c.
Flashing (over doors also)
2"x4" studs 24" o.c.
½"x12" Bolt-8' o.c.
Slope 2
Slope ½
Cross Section-A-A
Scale: ½"=1'-0"
To Cesspool
33'-6"
11'-0"
21'-0"
8'-0"
Drain
Manger
Milk Room
Slope 2"
Drain
Walk-Way
Screen
4'-0" x 7'-0"
Concrete Slab
Concrete Slab Shed Over
12'-0"
15'-0"
10'-0"
Floor Plan
Scale: ⅛"=1'-0"
Left Elevation
Scale: ¼"=1'-0"
Front Elevation
Scale: ¼"=1'-0"
Galv. Metal-2"x4" 3' o.c.
2"x6"-24" o.c.
1"x6" Ceiling
2"x4"
1"x6" Wall Ceiling
2"x4" Studs-24" o.c.
1"x12" Car Siding
½"x12" Anchor Bolt-8' o.c.
Section of Milk Room
Scale: 1"=1'-0"
2"x4" Bracing
2"x4 Wall Studs
3'-0"
2'-0"
2'-0"
Detail of Stud Bracing
Scale: 1"=1'-0"
Note! The minimum height of the concrete wall from the floor level should be 1'-6". However, the concrete wall may be extended to the height of the window sill if desired.
Note! The milk and wash room must be ceiled throughout. It is preferable to have the wall ceiling put on vertically to facilitate cleaning.
Minimum Sizes of Milk Rooms
Milk output. Min. Room Size:
under 50 Gal 12' x 12' or 144 sq. ft.
50-100 Gal. 12' x 14' or 168 sq. ft.
100- Gal 12' x 16' or 192 sq. ft.
Cooperative Extension Work
in Agriculture and Home Economics
Louisiana State University & A & M. College
& U.S.D.A. Cooperating
Six Cow Dairy Barn
Drawn by J.D. Carter
Traced by J.D. Carter
Checked by C.J. Hutchinson
Sheet 1 of 1
April, 1941
No 4005
Approved by H.G. McAndrews


Galv Metal on 2"x4" - 3'0"o.c.
2"x6" - 24" o.c. - 16' Long
Flashing -
(over doors also)
7'-0"
Slope 1/2"
5'8"
4'4"
1/2"x12" Bolt 8'o.c.
· Cross Section · A · A
Scale · 1/2"=1'-0"
A
45'0"
To Cesspool
Manger
Drain
· Walk Way ·
Milk Room
Wash Room
Slope 2" to Drain
3'0"x7'0"
Screen
6' x 10' Concrete Slab
Concrete Slab · Shed over
22'-6"
3'9"
· Floor Plan ·
Scale · 1/2"=1'-0"
· Left Elevation ·
Scale · 1/4"=1'-0"
· Front Elevation ·
Scale · 1/4"=1'-0"
Galv Metal · 2"x4" - 3' o.c.
2"x6" - 24" o.c.
1"x6" Ceiling -
2"x4"
1"x6" Wall Ceiling
2"x4" Studs - 24" o.c.
1"x12" Car Siding -
1/2"x12" Anchor Bolt - 8' o.c.
Section of Milk Room ·
Scale 1"=1'-0"
2"x4" Bracing
3'-0"
2"x4" Wall Studs
2'-0"
2'-0"
· Detail of Stud Bracing ·
Scale: 1"=1'-0"
Note! The minimum height of the concrete wall from the floor level should be 1'-6". However, the concrete wall may be extended to the height of the window sill if desired.
Note! The milk and wash room must be ceiled throughout. It is preferable to have the wall ceiling put on vertically to facilitate cleaning.
Minimum Sizes of Milk Rooms:
Milk output — Min Room Size
under 50 Gal — 12' x 12' or 144 sq ft
50 - 100 Gal. — 12' x 14' or 168 sq ft.
100 - Gal — 12' x 16' or 192 sq ft.
Cooperative Extension Work
in Agriculture and Home Economics
Louisiana State University & A & M College
& U.S.D.A. Cooperating
· Six Cow Dairy Barn ·
Drawn by: J.D. Carter
Traced by: J.D. Carter
Checked by: C. J. Hutchinson
Sheet 1 of 1
April, 1941
No. 4006
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Public Sewage Disposal

1. General Considerations. Although the history of public sewerage systems dates back into antiquity, the modern sewerage system came into being about the middle of the 19th century. The introduction of the water carriage system of sewage disposal did away with the offensive accumulation of filth around city dwellings, but gave rise to a series of stream pollution problems which the sanitarians are today endeavoring to solve. Where streams are large the problems tend to be less, and where strems are small the problems tend to be great. Water supplies may become infected as a result of stream pollution and in some instance great epidemics have been the result. Thus the problem of the removal of fecal matter was sometimes solved at one place only to reappear elsewhere.

Sewage is the used or spent water supply. It is made up of 99.9% water and .1% solids. This .1% of solids is the important part of sewage. It is composed of:(a) floating solids, (b) fats and oils, (c) settleable solids, (d) non-settleable solids or putrescible solids, (e) bacterial life, (f) soluble organic or inorganic nature. Up to about 1930 the bulk of sewage was disposed of by dilution, i.e. dumped untreated into some body of water. Today less than 25% of metropolitan sewage is disposed of by unmodified dilution techniques.

Sewage has a chemical, physical, and bacterial effect on water. The chemical properties of water may or may not impair its utility. When the chemical properties are such as may make it a hazard to human consumption it is called "contaminated". Contamination is also the introduction into water of human or animal wastes which may transfer infection. When the physical properties are such as to make it objectionable in appearance, taste or odor it is called "polluted"

2. Stream Pollution and Self Purification. The average amount of sewage per capita per day for the urban population of the U.S. is 100 to 120 gal. The average sewage of urban origin contains about 100,000 microorganisms per cubic centimeter.

Our average water treatment plants (using sedimentation, coagulation, filtration, and chlorination processes) can operate successfully if the sewage does not cause river water to exceed 5,000 coliform bacteria per 100 c.c. or 2,000 coliform per 100 c.c. for lake water. Therefore sewage treatment must be efficient enough to bring down the counts of the contaminated waters to these figures. If only chlorination is used for water treatment then the raw water should not exceed 60 to 100 bacteria per 100 c.c. If double coagulation and pre- and post-chlorination are used besides the other processes (sedimentation and filtration), then the raw water may have a bacterial count as high as 20,000 organisms per 100 c.c.

The General Classification of Raw Water

Class A raw river water does not exceed 5,000 bacteria per 100 c.c.
Class A raw lake water does not exceed 2,000 bacteria per 100 c.c.
Class B raw river water does not exceed 20,000 bacteria per 100 c.c.
Class B raw lake water does not exceed 5,000 bacteria per 100 c.c.
Class C raw river water does exceed 20,000 bacteria per 100 c.c.
Class C raw lake water does exceed 5,000 bacteria per 100 c.c.

Class A indicates that the water is in good condition and no restraining measures against stream pollution are required. Class B indicates that the water is practicable for use but control measures should be maintained against excessive stream pollution. Class C indicates that restraining measures against stream pollution should be obtained.

The objectionable factors in sewage disposal are: (a) the scum produced on the surface of the water, (b) the sludge accumulation along the banks of streams, (c) the odors (H_2S) developed due to the limited amount of dissolved oxygen in the water.

Important factors to be considered in stream pollution are: (a) public water supply, (b) nuisance, (c) bathing and recreation, (d) shellfish, (e) fish and natural life, (f) live stock, (g) property, (h) navigation-accumulation on river bed-effect on boat corrosion,(i) natural ice.

The discharge of sewage, whether treated or not, into streams, lakes and harbors is by far the most common method of sewage disposal of urban areas throughout the world. It can be applied satisfactorily whenever the water receiving the sewage is capable of bearing the load placed upon it. When this is the case, the heavy particles settle to the bottom, the organic matter is oxidized by the O_2 dissolved in the water, and the bacteria gradually die

off for lack of suitable food. This condition is generally brought about by their own consumption of the available foodstuffs. The bacteria are also consumed by other organisms, killed by sunlight, or otherwise destroyed. The result is the phenomenon known as the self-purification of streams. When, however, the burden placed upon the water is too great, self-purification is protracted, water supplies may become polluted, oyster beds may become infected, and in severe cases streams may be so overloaded with sewage as to become offensive to sight and smell.

3. Biochemical Oxygen Demand. The amount of dissolved oxygen in the water of a stream is a most important determination in the study of pollution. The amount of oxygen found is an indication of the load which is being put upon the natural processes of purification. The self purification of a stream of water is accomplished through the process of oxidation-reduction. This self-purification of water (and soil) is a remarkable phenomenon and is described as a chain of processes making up part of the most vital and complicated processes known as the "nitrogen cycle". Self purification may occur in the presence of free molecular oxygen and in the presence of anaerobic bacteria. The first type of oxidation occurs in decomposing organic material which produces less offensive odors. The second occurs in the absence of air and produces very offensive odors. It is for this reason, i.e., anaerobic putrefactive processes, that streams overloaded with organic material so that the dissolved oxygen is too low to allow aerobic decomposition, produce such violently offensive odors.

Water in contact with air becomes saturated with oxygen. Being held in solution, as a gas in a liquid, the oxygen is termed "dissolved oxygen". The actual amount of oxygen dissolved in water will depend upon the partial pressure of oxygen in the atmosphere and also upon the barometric pressure and the temperature of the water. In most cases temperature is the controlling factor, for the amount of oxygen dissolved varies greatly with the temperature. Thus, distilled water at $0^{\circ}C$. and 760 min. pressure holds, when saturated, 14.62 parts per million of O_2; at 20° it holds 9.17 parts. Without O_2 water has a flat, insipid taste.

There are many processes which go on in water that influence the dissolved O_2 content. Clean surface waters are ordinarily saturated, but in the presence of rapidly growing plant life, particularly algae, supersaturation often occurs due to liberation of O_2 by the plant cells. At the same time there is a reduction of the carbon dioxide content which is used as food for plant growth. The relation of dissolved gases to microscopic growth in water is close and important.

When water is polluted with any oxidizable material such as the extracted matter from dead vegetation, sewage, or other wastes, the O_2 content will be diminished, but may be replenished by absorption from the atmosphere if the pollution is not heavy and decomposition not too rapid. When the demand of bacterial activity for O_2 exceeds the rate at which oxygen can be dissolved from the air (practically all decomposition or putrefaction is associated with bacterial activity) the value in the water will fall and as it approaches zero, putrescible conditions arise due to anaerobic bacterial processes. This results in the production of partially oxidized compounds which possess obnoxious physical properties. In surface waters receiving sewage or industrial wastes this condition may establish a nuisance.

Dissolved O_2 is a most important determination in the study of pollution and the amount of O_2 found is an indication of the load which is being put upon natural processes of purification. The amount found in the water of a running stream at different points, for instance, furnishes valuable information as to the rapidity with which self-purification is taking place below a given point of pollution. The greater the volume of the stream the greater the dilution and the less the demand on dissolved O_2. The faster the stream flows the less time it takes to reach a certain point down the stream and the greater the demand for dissolved oxygen prevails.

Oxygen bears an important relation to fish life. Most fish will live when the oxygen content is as low as 50 to 60% of saturation. Below this point suffocation takes place. Therefore where sewage is dumped into streams, the character of the sewage in relation to the size of the stream should be such that the utilization of the dissolved O_2 should not be great enough to reduce the dissolved O_2 content of the water below 5 p.p.m. which will allow fish life to exist. Adequate dissolved O_2 for fish life is 6.5 p.p.m.

The amount of dissolved O_2 required for satisfactory oxidation of organic material (such as sewage) is called the "bio-chemical oxygen demand", or B.O.D. Thus, if the daily available O_2 in a stream is 22 lbs, and the B.O.D. of sewage to be emptied into it is 125 lbs. of O_2 daily, the B.O.D. of the sewage will have to be reduced by 84% ($\frac{125 - 22}{125}$) in order not to cause undesirable conditions in the stream.

4. Dilution Factors. When sewage is discharged into streams the dilution must be great enough in the stream in order to prevent offensive situations. This dilution is measured

in terms of the rate of flow of the stream into which the sewage is emptied as for example, cubic feet per second per capita, and these factors are known as "dilution factors". Dilution factors at present are arbitrary, since they have not been worked out with precision. For various types of sewage the tentative dilution factors are:

a. For raw sewage - 10 cubic feet per second per 1,000 persons
b. For settled sewage - 40% less than for raw sewage
c. For effluent from a trickling filter plant - 80% less than for raw sewage
d. For effluent from an activated sludge plant - 90% less than for raw sewage.

The amount of sewage emptying into a stream should not be more than 1/40 to 1/20 of the water flowing in the stream. Adequate dilution is about one part sewage to one hundred parts water. Thus, the factors upon which the degree of treatment selected for domestic or industrial waste depend upon:

a. Rate of flow of stream into which sewage is emptied
b. The nature of the sewage to be treated
c. The allowable character of the effluent considered with reference to the use made of the water into which it is to be discharged
d. The availability of suitable areas of land at proper elevation
e. The costs of construction and operation.

5. Collection of Sewage. Offensive situations may be caused not only in the streams but also in the sewerage system if the quantity of sewage to be handled and the velocity at which the sewage must be carried is not adequate to prevent deposition of solids with consequent clogging of sewers or with accumulation of deposits subject to decomposition. These factors determine the size and grade or slope of the sewers. The smallest size of sewer employed is generally 8 inches in diameter and the grades are so chosen that the velocities of flow will be in the vicinity of 2 feet per second in the case of sanitary sewers and 3 feet per second for combined and storm sewers. To permit inspection and cleaning of the sewers, manholes are provided at all changes in grades and direction of the sewers; also at intermediate points in the case of long straight runs. These structures are placed not less than 300 feet apart in the case of small sewers; their distance may be increased to 400 feet for large sewers.

6. Sewage Treatment. The history of sewage disposal from ancient time to the present is an acceleration and concentration of natural processes on a smaller and smaller unit of land per unit of population. The following comparison illustrates this trend:

a. Sewage takes only a relatively short time to pass through an Imhoff tank but the sludge material may take 6 to 9 months to become completely digested into relatively inert material,i.e.stabilized.
b. Sewage passes over a trickling filter in even shorter time through an Imhoff tank but the solids in the sewage may not become completely digested into relatively inert material for 3 to 6 months, i.e. stabilized.
c. Although sewage may pass through the digesting chamber of an activated sludge process in several hours, the resulting solids will not become completely stabilized into relatively inert material for about 20 to 30 days, i.e. stabilized.

The fundamental processes in sewage treatment are:

a. Separation of suspended matter from the liquid sewage
b. Destruction of the putrescible organic matter in the liquid sewage and final mineralization by the processes of oxidation and bacterial action
c. Transformation of the sewage sludge to condition of stability and inertness by bacterial action
d. Destruction or removal of the bacteria from the liquid effluent.

The processes involved may be classified as follows:

a. Preparatory processes such as screening, skimming, sedimentation and chemical precipitation.
   (1) Coarse screens - hold back the largest floating objects and prevent injury to pumps at pumping stations.
   (2) Fine screens - hold back smaller sewage particles which may form scum upon settling tanks. Renders chlorination more efficient.
   (3) Sedimentation tanks - allows finer particles to settle out and lessens the load of the liquid sewage.
   (4) Septic tanks - allows finer particles to settle and change into liquid and gas by anaerobic bacterial action.

(5) Chemical precipitation - precipitates the non settleable colloids further reducing the load of the liquid sewage.
(6) Skimming - removes oil and grease which may interfere with the treatment process.
(7) Grit chambers - removes grit and detritus which may cause excessive wear to pumps and screens.

b. Key processes, such as subsurface irrigation, broad irrigation, intermittent filtration, contact and trickle filter treatment, and activated sludge treatment. These methods utilize the self-purification principle involved in the "nitrogen cycle".
(1) Surface irrigation fields - historically an old method of disposal of sewage, still used extensively abroad.
(2) Subsurface irrigation - requires sandy soil - satisfactory only for small disposal plants.
(3) Intermittent sand filtration - allows aeration, oxidation and aerobic activity of bacteria to reduce organic matter to non-putrescible material. Very efficient.
(4) Contact beds - water tight compartments filled with broken stone or coke catch suspended particles. Mineralization takes place by oxidation and bacterial activity. Allows partial purification.
(5) Trickling filter - allows aeration, oxidation and bacterial action of organic material as it filters through porous bed impregnated with slimy gelatinous growths of microorganisms. Fairly efficient.
(6) Activated sludge - allows aeration of sludge by forcing air through tank containing sludge or by a process of exposing the sludge to air in thin films. Produces aerobic bacterial action in entire media with clarification, nitrification and reduction of bacterial content of sewage. Good efficiency in reducing load.

c. Finishing processes such as secondary sedimentation tanks and disinfection are used to reduce whatever suspended matter and bacteria are left after the sewage goes through the key processes.
(1) Secondary sedimentation tanks - allows completion of self-purification process in sewage from the key processes.
(2) Disinfection - none of above processes can be relied upon to furnish an effluent free from pathogenic organisms, therefore liquid chlorine or chloride of lime (most commonly used) are employed to finally reduce the bacterial content of the treated sewage.

7. Efficiency of Various Treatment Processes. The relative sanitary efficiency of various processes employed in sewage treatment follows: (2)

Process	% of Removal of Bacteria
Coarse Screens	0 to 5
Fine Screens	10 to 20
Grit Chambers	10 to 25
Sedimentation	25 to 75
Septic Sedimentation	25 to 75
Chemical Precipitation	40 to 80
Contact Beds	About 80
Trickling Filters	90 to 95
Activated Sludge Process	90 to 98
Intermittent Sand Filters	95 to 98
Broad Irrigation	97 to 99
Disinfection of Raw or Settled Sewage	90 to 95
Disinfection of Filter Effluents	98 to 99

Another set of figures, as follows, show the degree treatment rendered by various processes and groups of processes in terms of the reduction of B.O.D., and also the dilution factors required for the sewage treated by the corresponding processes:

Kind of Treatment	% Reduction in B.O.D.	Dilution Factors
Raw or Coarse Screen	5	6-8 cu.ft.per sec.per 1,000 persons
Fine Screen	8 to 10	5.5 " " " " " " "
Fine Screen plus Chlorine	20	4.8 " " " " " " "
Sedimentation	35	3.9 " " " " " " "
Sedimentation plus Chlorine	50	3.0 " " " " " " "
Sedimentation plus Coagulation	65	2.1 " " " " " " "
Sedimentation, Coagulation Plus Chlorine	70	1.8 " " " " " " "
Complete, (Sedimentation Plus Oxidation)	85-92	0.5 to 1.0 " " " " "

The self purification of streams and therefore the reduction in B.O.D. depends upon the volume of its water and the time elapsing after discharge of sewage into it. Under ordinary conditions, about a 95% reduction in coliform bacilli occur after 2 to 5 days exposure in moving stream (river); about a 90% reduction in B.O.D. occurs after 5 to 10 days of sewage exposure in a moving stream (river).

6. Sewage Analysis. Many of the determinations commonly included in sewage analysis are the same or similar to those of water analysis. Most of the tests give indirect or inferential information as to the properties of the sewage and it becomes necessary to interpret the analysis as a whole rather than drawing information from separate tests. The choice of tests depend upon the information desired. In general, sewage is analyzed for the purpose of predicting or determining its effect upon water courses into which it may be discharged, or for predicting the required degree of treatment or determining the efficiency of the treatment process. The variety of tests are: (2)

a. Those measuring organic matter.
  (1) B.O.D. and relative stability
  (2) Volatile solids or loss on ignition (includes some mineral matter)
    a) Suspended; settleable and non-settleable
    b) Dissolved
  (3) Organic nitrogen (also albuminoid nitrogen)
  (4) Oxygen consumed (a measure of the carbonaceous matter)
  (5) Ether-soluble matter (fats).

b. Those measuring mineral matter.
  (1) Fixed solids, or residue after ignition
    a) Suspended; settleable and non-settleable
    b) Dissolved
  (2) Ammonia nitrogen (includes some organic matter)
  (3) Nitrite and nitrate nitrogen
  (4) Chlorides, hardness, alkalinity and iron.

c. Those measuring both organic and mineral matter.
  (1) Total solids, or residue on evaporation
    a) Suspended; settleable and non-settleable
    b) Dissolved
  (2) Hydrogen iron concentration.

d. Those measuring gases.
  (1) Dissolved oxygen
  (2) Hydrogen sulphide
  (3) Carbon dioxide.

e. Those measuring living organisms.
  (1) Bacteria at 20°C. for 24 hours, 37°C. for 48 hours on agar plate; Bact. coli.
  (2) Plankton; animal and plant forms - notably protozoa, crustaces, rotifers, fungi and higher bacteria.

Comparative Average Sewage Analyses for American Cities (2)

Sewage Flow and Constituents	Large Combined Sewers	Character of Cities		
		Manufacturing	Small Manufacturing	Residential
Sewage flow-Gal. per capita daily	200 p.p.m.	100 p.p.m.	70 p.p.m.	50 p.p.m.
Biochemical oxygen demand	200 "	230 "	280 "	140 "
Solids - total	1350 "	1160 "	730 "	600 "
Volatile	430 "	640 "	450 "	390 "
Fixed	900 "	420 "	280 "	210 "
Suspended	210 "	390 "	240 "	340 "
Volatile	140 "	290 "	200 "	260 "
Fixed	70 "	100 "	40 "	80 "
Dissolved	1040 "	670 "	490 "	260 "
Volatile	240 "	330 "	250 "	130 "
Fixed	800 "	340 "	240 "	130 "
Nitrogen - organic	8 "	24 "	24 "	18 "
Ammonia	11 "	27 "	39 "	27 "
Oxygen - consumed	60 "	130 "	110 "	70 "
Chlorides	50 "	110 "	80 "	50 "
Fats	25 "	37 "	---	---
Bacteria per capita	1300 billion	---	---	---
Bact. coli per capita	250 "	---	---	---

The average 5 day B.O.D. for sewage is about 260 p.p.m.
The average amount of suspended solids in sewage is 250 p.p.m.
The average amount of settleable solids in sewage is 5.4 c.c. per liter
The average amount of nitrogen as NH_3 in sewage is 15 p.p.m.
The average amount of organic nitrogen in sewage is 22 p.p.m.

TYPICAL IMHOFF TANK, SEWAGE TREATMENT PLANT INSTALLATION (See Illustration "A",Page 181)

1. Imhoff Tank. The Imhoff tank, like the septic tank, combines sedimentation with sludge digestion. There is, however, an important difference: digestion takes place in a separate compartment from that where sedimentation occurs. This digestion chamber is indicated as "b" on the cross section sketch of the Imhoff tank. The sludge compartments of Imhoff tanks in Southern locations should have approximately the same capacity volume as that used for unheated separate sludge digestion tanks, which is 3.0 cu. ft. per capita. The sludge capacity should be computed from a line 18 in. below the slot, indicated by "d" on the cross section sketch. Since there is no intimate contact in the Imhoff tank between the incoming sewage and the digested sludge, a better effluent is obtained. The gases in septic tanks which, in rising, inhibit the settling of the sludge, are diverted by the sloping walls in the Imhoff tank. These diversion chambers or gas vents are shown as "e" in the cross section sketch. The sedimentation compartment "A" of the Imhoff tank is usually designed for a velocity which will not exceed 1 ft. per minute at peak flows. The retention periods in the sedimentation chamber is 1½ to 2 hours. Sludge is drawn off every 30 to 45 days from the sludge compartment by means of a sludge draw off line indicated by "c" on the cross section sketch.

2. Dosing Tank. In the smaller installations a dosing tank is usually provided to discharge sewage intermittently to the secondary treatment system. These dosing tanks are usually designed so that they will operate for a 10 minute period and provide a rest period of about 20 minutes. Automatic siphon equipment regulates the dosing operation.

3. Rotary Trickling Filters. Low capacity trickling filters are usually used on the smaller sewage treatment plants in Louisiana. These filters usually provide a biochemical oxygen demand reduction of 85 percent to 95 percent. The low capacity filters are designed for loadings not to exceed 600 pounds per day of applied B.O.D. per acre foot. The filters should not be greater than 6 ft. in depth.

4. Final Settling Tank. Final sedimentation tanks are usually provided for treatment plants where trickling filters are used. These tanks have a retention period of approximately 2 hours. The tanks can either be provided with mechanical scrapers to remove the sludge to a hopper in the bottom, or the tanks can have a steep bottom slope so that the sludge can be drawn off by gravity through the sludge draw off line. In the latter, the slope is usually about 45 degrees. Sludge is usually drawn from the tanks 2 or 3 times during each day. The sludge that is drawn off is returned to the inlet end of the Imhoff tank. The final effluent from the settling tank is discharged after being chlorinated to the stream.

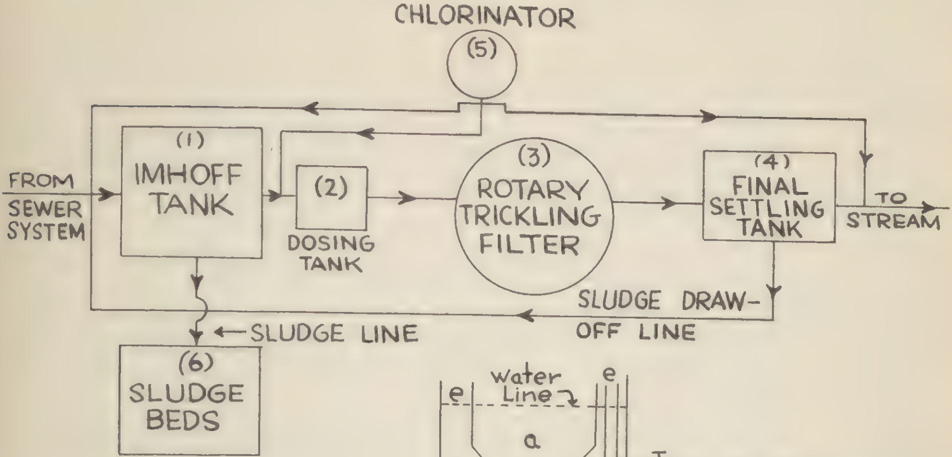
5. Chlorination. Chlorination is usually of the 3 point type. Chlorine is applied to the inlet end of the Imhoff tank to the dosing tank and to the effluent of the final settling tank. The first two points of application are used for odor control and the last point is for sterilization. In chlorinating for odor control, it is essentiaal that chlorine be applied only in amounts to neutralize the objectionable odors. No residual chlorine should be maintained. In chlorination for sterilization, a residual chlorine of from 0.1 parts per million to 0.2 parts per million should be maintained.

6. Sludge Drying Beds. The sludge that is drawn from the Imhoff tank is discharged on to sludge drying beds. Open sludge drying beds are usually used in Louisiana, the beds consisting of about 12 in. of sand and 6 in. of graded gravel. The beds are provided with a underdrain system. Approximately 1.25 sq. ft. of bed surface per capita is provided. During rainy seasons, it is frequently found that great difficulty is experienced in drying sludge. In order to accellerate the drying, alum is frequently found to be helpful if applied to the sludge as it is discharged on to the beds.

TYPICAL ACTIVATED SLUDGE PLANT INSTALLATION (See Illustration "B",Page 181)

1. Primary Settling Tank. The primary settling tank and activated sludge plant installation are designed for retention periods of 1½ hours. The tanks are usually provided with mechanical sludge collectors used to move the sludge to a hopper. The sludge collecting device is of the endless chain type and is usually arranged so that the sludge is moved to the hopper at the bottom while, at the same time, the endless chain skims the floating materials from the surface of the liquid. The surface skimmings are discharged into a trough at the opposite end of the tank where the sludge is collected. Two or three times during the day the sludge is drawn from the primary settling tank and skimmings collected in the trough are removed.

TYPICAL SEWAGE TREATMENT PLANT INSTALLATION



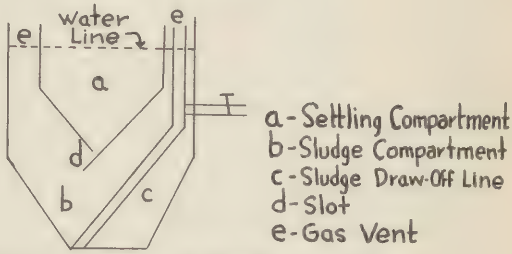


ILLUSTRATION "A"

IMHOFF TANK CROSS SECTION

TYPICAL ACTIVATED SLUDGE PLANT INSTALLATION

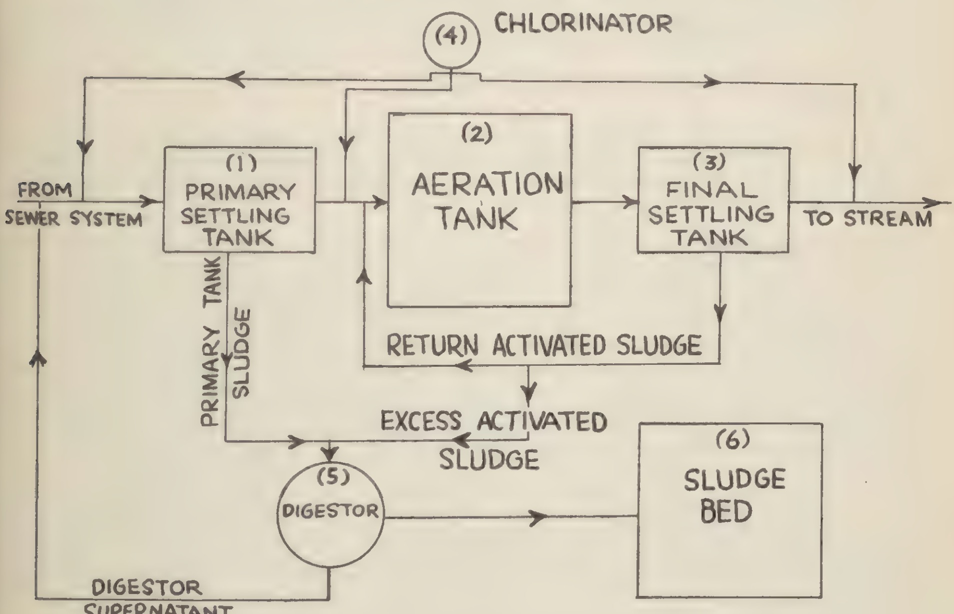


ILLUSTRATION "B"

2. Aeration Tank. Aeration is provided either by means of compressed diffused air or by mechanical devices. When compressed air is used the retention period is approximately 8 hours. When mechanical devices are used, the retention period is 12 hours. When compressed diffused air is used, the rate of application is approximately $1\frac{1}{2}$ cu. ft. of free air per gallon of sewage treated.

3. Final Settling Tank. The construction of the final settling tank is a great deal similar to the primary settling tank. Scraping devices are provided on the bottom to remove the sludge to the hopper. Skimming devices are not used on these tanks as very little floating material is obtained. A proportion of the sludge collected in this final settling tank is returned to the inlet end of the aeration tank. This sludge is known as "activated sludge". The return flow is approximately 20 to 25 percent of the total flow in the aeration tank. The effluent from the final settling tank is removed by means of a weir and discharged after chlorination to the stream.

4. Chlorination. Provisions are usually made to provide three point chlorination. Provisions should be made to chlorinate either the raw sewage entering the primary settling tank, the effluent from the primary settling tank, or the effluent from the final settling tank. The first two points are provided for odor control and the last point for sterilization. In chlorination for odor control, a sufficient amount of chlorine should be added only to neutralize the odors. A residual chlorine content should not be maintained. For sterilization a residual chlorine content of between 0.1 p.p.m. and 0.2 p.p.m. should be maintained.

5. Digestor. The sludge withdrawn from the primary settling tank, and the surplus sludge from the final settling tank, is discharged to the digestor. When heating facilities are used in the digestor, a capacity of 4.0 cu. ft. per capita should be provided. When the digestor is unheated, a storage capacity of 6.0 cu. ft. per capita should be provided. Heated digestors are usually maintained at a temperature of 90 degrees Fahrenheit. Some digestors are provided with floating covers in which the gases generated from the digestion processes are collected. These gases are used to operate sludge pumps, air compressors, and other units of the plant. The supernatent or top liquor from the digestor is returned to the inlet end of the primary settling tank.

6. Sludge Bed. Sludge is withdrawn from the digestor every 30 to 45 days. This sludge is discharged on to sludge beds. The sludge beds are constructed so that they have approximately 12 inches of sand, 6 inches of graded gravel and an underdrain system. The beds are designed for a surface area of approximately 1.25 sq. ft. per capita. In the Southern states the beds are usually uncovered. During rainy seasons it is frequently found that great difficulty is experienced in drying sludge. In order to accelerate the drying, alum is frequently found to be helpful if applied to the sludge as it is discharged on to the beds.

TESTS FOR SEWAGE (6)

The main purposes of analyses and tests made at sewage treatment works are: (1) For control of operation, (2) For record of accomplishment, and (3) For research investigation. The following tests are the most commonly used in evaluating the character of sewage, industrial wastes and polluted waters.

1. Biochemical Oxygen Demand (B.O.D.) If oxygen is furnished to a sewage or treatment plant effluent containing bacteria, aerobic decomposition will occur until the oxygen demand is satisfied. The amount of oxygen absorbed during this self-purification process is known as the biochemical oxygen demand. It is an important indication of the amount of organic matter in the sample. The magnitude of the demand, therefore, depends upon the organic matter present, while the rate at which the demand is satisfied depends upon the temperature and remaining demand. With an oxygen supply available satisfaction of the demand, that is, reduction of B.O.D. proceeds rapidly for 6 or 7 days and then slows up until the end of 20 days. Therefore it may accelerate for a time and again slow up to a very low rate for an indefinite period. The demand exerted during the first 20 days is ascribed to oxidation of carbonaceous matter and is known as the first stage, or initial demand. The later demand is considered to be due to nitrification.
The B.O. D. test consists of diluting the sewage with water containing a known amount of dissolved oxygen and noting the loss of oxygen after a period of storage. The usual storage or incubating period is 5 days with an incubating temperature of 20°C. The diluting water is aerated, contains a small amount of sodium bicarbonate and has a pH of 7.0 to 7.6. If the sewage has been sterilized with chlorine or some other agent, it will also be necessary to seed with bacteria before incubation, since bacteria are necessary for the process. The rate of disoxygenation is assumed to be directly proportioned to the amount of organic matter present in the sample. The formula and mathematical procedure for making the calculations are rather complicated and will not be given here. For further information, consult

"Standard Methods for Examination of Water and Sewage". This test is used both for raw and treated sewage.

2. Relative Stability Test for Effluents. Since the satisfaction of B.O.D. proceeds according to a fairly well defined time schedule, a test that will indicate when the oxygen present in a polluted water or plant effluent is exhausted will also show the proportion of first stage demand that has been satisfied. Such a test has been devised. It consists of adding a small portion of an aniline dye, methylene blue, to the sample. When the oxygen is exhausted, anerobic conditions will be set up, and the color of the dye will be bleached by the sulfur compounds generated.
Relative stability may be defined as the percent ratio of oxygen available as dissolved, nitrite and nitrate oxygen to the total oxygen required to satisfy the biochemical oxygen demand. This percentage or ratio may be approximately indicated by determining the number of days required to exhaust the available oxygen in the sample, using methylene blue as an indicator. (This methylene blue is prepared by dissolving 0.5 g. of U.S.P. methylene blue tablet in one liter of distilled water).
The use of this determination is rapidly decreasing, as it is being replaced by the more exact determination of dissolved oxygen, nitrite, nitrate and biochemical oxygen demand. However, for small plants with limited laboratory facilities the stability towards methylene blue fulfills a very useful service in indicating the satisfactory operation of the biological oxidation processes.
Effluents which contain caustic alkalinity or acidity should be neutralized to brom thymol blue and seeded with sewage bacteria before adding the indicator. If bactericidal substances are present that cannot be removed, the method is inapplicable.
The theoretical relation between the time required for decolorization of methylene blue at 20°C. and the relative stability percentage is given in the Table below and is represented by the relation $S = 100\,(1 - 0.794^{t})$ in which S is the stability in percent and t is the time in days required for decolorization at 20°C.

Procedure - Fill a 150 mil. glass stoppered bottle with sample, avoiding aeration. Add exactly 0.4 ml. of methylene blue indicator solution below the surface of the liquid. Incubate at 20°C. with a water seal, observing the samples daily until decolorization takes place. Report the days required for decolorization, or if preferred, the relative stability percentage shown in the table below. If other sized incubation bottles are used a proportional amount of the indicator solution must be used.

Relative Stability Numbers

Time required for decolorization at 20°C.	Relative stability S.	Time required for decolorization at 20°C.	Relative stability S.
Days	Percentage	Days	Percentage
0.5	11	8.0	84
1.0	21	9.0	87
1.5	30	10.0	90
2.0	37	11.0	92
2.5	44	12.0	94
3.0	50	13.0	95
4.0	60	14.0	96
5.0	68	16.0	97
6.0	75	18.0	98
7.0	80	20.0	99

3. Total Residue on Evaporation. Evaporate 100 ml. of sample in an ignited and tared dish, dry to constant weight at 103°C., cool in desiccator and weigh. (This usually requires $2\frac{1}{2}$ hours drying at 103°C.)
The mg. per liter shall be reported as parts per million total residue. This total residue includes both organic and mineral solids in sample.
Total volatile and fixed solids are determined by igniting the above total residues at 600°C. in an electric muffle (usually requiring 10 to 15 minutes).
The mg. loss on ignition per liter shall be reported as parts per million volatile solids and the mg. residue per liter as parts per million fixed solids.
These results on total residue, volatile solids and fixed solids are subject to considerable error because of losses of volatile compounds during evaporation, of carbon dioxide and volatile minerals during ignition, and to the presence of calcium oxide in the ash. In the interpretation of results these possible errors must be recognized.

4. Tests of Solid Content. Tests for solids, particularly the suspended solids, show the concentration of sewage. They also provide a check upon the efficiency of sedimentation tanks, and other treatment units. Suspended matter in completely treated sewage usually

has a higher proportion of fixed solids than that in raw or settled sewage. The settleable solids are those which settle in 1-3/4 hours in an Imhoff cone or glass. The test is generally used to gain some idea of the efficiency of a sedimentation tank. A parallel test is run on both influent and effluent.

Suspended Solids. Procedure: Prepare a mat of asbestos fiber (acid-washed, medium fiber asbestos plus distilled water) from 2 to 3 mm. thick, in a Gooch crucible by gentle suction. Wash with 100 ml. of distilled water, dry at 103°C., cool and weigh. If volatile matter is to be determined by ignition the crucible and mat must be ignited, cooled and weighed. Filter from 50 to 100 ml. of sample through the weighed Gooch crucible using suction. Dry at 103°C. for 2½ hours, cool in a desiccator and weigh. (The volume of sample should yield less than 30 mg. of solids). Report the mg. solids per liter as parts per million suspended solids.

Dissolved solids may be obtained by difference or by determination in a filtered sample, according to above procedures.

The volatilization of organic matter, carbonates and ammonium salts from sewage solids is subject to a great many errors. It should be done in an electric muffle furnace at 600°C. Ignite the suspended solids (10-15 minutes). Cool in a desiccator and reweigh. Report the mg. lost on ignition per liter as parts per million of volatile suspended residue and the mg. ash per liter remaining as parts per million fixed suspended residue. However, in plant control laboratories, ignition may be accomplished over a Meeker burner, heating the dish to a dull red heat until no black carbon specks remain. The ash should be white or reddish brown.

Settleable Solids (By volume). Fill an Imhoff cone to the liter mark with a thoroughly mixed sample. Settle for 1.75 hours, gently stir the sides of the cone with a rod or by spinning, settle 0.25 hour longer and record the ml. of settleable solids in the cone. In hot weather it may be necessary to reduce the settling to 1 hour because of floating sludge. Some operators prefer to use the theoretical detention period of the plant settling units. (By weight) If it is desired to determine the settleable solids by weight most of the supernatant liquor is siphoned off and the settled solids washed into a tared evaporating dish, evaporated, dried and weighed. The weight in mg. equals parts per million settleable solids. Corrections should be made for the dissolved solids in the supernatant liquor which is dried with the settleable solids, if greater accuracy is desired.

5. Hydrogen Ion Concentration or pH Test. Same as described under tests for water.

6. Residual Chlorine Test. (Colorimetric Determination) The method outlined in this section is intended for use in the determination of residual chlorine in sewage, sewage effluents, industrial and polluted waters, and not for waters in any stage of treatment for, or completely prepared for, use as a public water supply.

The high alkalinity of sewage requires an ortho-tolidine reagent with greater acidity than that for water treatment plant control and therefore the following procedure is recommended. The stronger acid also greatly reduces the interference by nitrites. The reagents are prepared as follows: Ortho-tolidine solution. Dissolve 1 g. of ortho-tolidine in 1 liter of hydrochloric acid (180 ml. HCL sp. gr. 1.18 to 1.19 diluted to 1 liter). It is sometimes easier to dissolve the orth-tolidine by grinding in the 180 ml. of strong acid and then diluting to 1 liter with distilled water.

Standard chlorine solution. Dilute 2.5 ml. of B-K solution (a pharmaceutical preparation of approximately 3.5 per cent sodium hypo-chlorite) to 1 liter with distilled water. This will give a solution of approximately 0.1 mg. of chlorine in 1 ml. of solution. This solution is not permanent and must be made up often and standardized frequently. Dilute solution so that 1 ml. contains 0.1 mg. of chlorine (H.T.H., Perchloron or other high grade hypo-chlorite solutions or salts may be used to make up this solution).

Standardization. To 150 ml. of distilled water add 1-2 g. of potassium iodide crystals and dissolve, add 50 ml. of chlorine solution, 1 ml. of concentrated hydrochloric acid and allow 5 minutes for liberation of iodine. Then titrate with N/40 sodium thiosulfate, using starch solution in the usual way until the blue color has disappeared. One ml. of N/40 sodium thiosulfate is equivalent to 0.886 mg. of chlorine, and mg. of Cl_2 per ml. = ml. N/40 sodium thiosulfate X 0.886 ÷ 50.

Procedure. To a 10 ml. sample of chlorinated sewage that has had at least a ten minute contact period (and has been warmed to 20°C. if the sample was cold) add 1 ml. of ortho-tolidine solution. Allow 5 minutes for development of maximum color and compare with color standards, made in the same manner, containing 0,0.2,0.4,0.6,0.8, and 1.0 mg. of chlorine per liter, in a turbidity compensating colorimeter. One ml. of the standard chlorine solution diluted to 100 ml. with distilled water is equivalent to 1 mg. per liter (1 part per million) of chlorine. The standards are not permanent and must be made up with each determination. Permanent standards including a colorimeter, are on the market, but such standards

must be checked against standard chlorine solutions.

INSTRUCTIONS FOR OPERATION AND CONTROL OF IMHOFF TANKS--Recommended by Louisiana State Department of Health.

Purpose.
1. To remove the settleable suspended solids in the sedimentation compartment.
2. To liquefy, gasify, and digest the settleable solids in the sludge compartment by bacterial action.

Construction and Function. To accomplish the above purpose, the Imhoff Tank is designed and built as a two-story structure, the upper or settling compartment serving for sedimentation and the lower or sludge compartment for bacterial digestion. A trapped slot between these compartments provides a means for the solids settled out of the sewage in the upper chamber to pass into the lower or sludge digestion compartment. This trapped slot also prevents the gases, resulting from decomposition in the digestion compartment, together with gas laden particles of sludge, from entering the settling compartment and from coming in contact with the settling sewage. These gases and gas laden particles are deflected by the sloping bottom of the sedimentation compartment and rise in the scum chamber or gas vent where the gases escape and a large part of the previously gas laden particles settles again. In a properly working tank, the gases given off should be inoffensive with a slightly tarry or gassy odor. Cleanliness is one of the fundamentals of a successfully operated plant. All accumulations of grease, grit, and refuse matter should be promptly removed and properly disposed of.

Operation.
1. Sedimentation Compartment:
   a. Grease and scum in the sedimentation compartment should be removed daily. This is best accomplished by the use of a dish shaped perforated skimmer. Such grease and scum should be promptly disposed of by burying or burning. Where objectionable conditions are not likely to develop, the grease and scum may be placed in the gas vents.
   b. The sides and slopes of the sedimentation compartment should be carefully scraped with a rubber squeegee and all solids pushed down through the slots at least every week.
   c. The slot in the bottom of the sedimentation compartment must be kept open and free from obstruction of any kind. Every other day the slot should be cleaned by the use of a chain drag, taking care to traverse the entire length of the slot.
   d. Failure to follow carefully the foregoing operation procedure will usually result in clogging of the nozzles of a trickling filter bed, if one is used and a deposition of solid matter or in such filter, due to grease, scum, or sludge being carried through the tank into the effluent.
   e. Where the design of the tank will permit, the direction of flow should be reversed in the sedimentation compartment at least once a month, in order to distribute the solids in the digestion chamber.
2. Gas Vents or Scum Compartment. The scum in the gas vent should be thoroughly broken up at least weekly to afford an easy escape for the gas from the digestion or sludge compartment. This may be accomplished by:
   a. Breaking the scum up with a hoe, rake, or other suitable tool.
   b. Hosing the scum in the gas vents with water under pressure.
   c. Keeping the scum in the gas vents saturated with sewage from the sedimentation compartment, or preferably liquor from the digestion compartment, by using a small portable pump or air lift device.
   d. Punching holes through the scum at two foot intervals with a wooden pole, 3 inches in diameter and 8 to 10 feet long.
   e. The scum may be removed and dried in a sludge drying bed if its depth approaches 2 to 3 feet.
3. Sludge Compartment.
   a. The height of the sludge in the sludge compartment should be determined at inlet and outlet ends of the tank at least once a month. The use of a pump for this purpose is the most desirable and satisfactory. The following are suitable methods for measuring the depth of sludge:
      (1) One method involves the use of a pitcher pump provided with a rubber suction hose, weighted on the end and the length marked on the hose at intervals of two feet, measuring from the weighted end toward the pump. The hose is gradually lowered through the slot in the sedimentation compartment, meanwhile constantly pumping and the length of immersed hose, when sludge first through the pump is determined. When sludge is encountered, the pump will usually "choke" before sludge appears.
      (2) A pitcher pump may also be used with a rubber suction hose, weighted on the end by a 4 foot length of steel pipe as an integral part of the pump suction lines. This suction hose may be graduated and marked as above and the determination of

a sludge depth made in the same manner except that the hose is lowered through the gas vent instead of the sedimentation compartment slot.

(3) The sludge depth may also be determined by use of an iron plate or weighted wooden block, about 12-18 inches square, attached to a wire or chain lowered through the gas vent. The plate or block will stop when the sludge is reached and the distance from the surface to the sludge level is determined by the graduated wire or chain by which the device is lowered.

(4) Where the condition of gas vents will permit the use of a lighter implement, a modification of the above may be used. This consists of a wire loop 12 or 15 inches in diameter, covered with a disc of quarter inch mesh wire. A very light chain should be used with this disc suspended at three points.

b. Sludge should be removed:

(1) Whenever the sludge depth approaches within 18 inches of the slot in the sedimentation compartment.

(2) In small amounts at frequent intervals rather than in large amounts at longer intervals. Usually some sludge should be drawn every month.

c. Sludge should be removed at a slow regular rate to avoid the formation of a channel through the sludge in the sludge compartment and the withdrawing of partially digested sludge or the liquid above the sludge.

d. If sludge does not flow readily, it may be started by:

(1) Agitating with water under pressure through perforated water pipes in the bottom of the sludge compartment. If such pipes are available, they should be properly protected to prevent back flow or back siphonage of the sewage in the tank to drinking water systems.

(2) Applying water pressure through hose immersed into the sludge compartment or to the sludge riser pipe.

(3) Agitating around sludge inlet with long rods through the sludge riser pipe.

e. After use, the sludge pipes should be flushed out and refilled with water or sewage to prevent the sludge from hardening and clogging the sludge pipes.

Operating Record

1. Number of tanks in service daily.
2. Daily flow.
3. Settleable solids in raw sewage and tank effluent as determined by Imhoff Cones daily.
4. pH of raw sewage and tank effluent.
5. Removal of sludge.
   a. Dates
   b. Cubic feet of sludge drawn as determined by the depth of the wet sludge bed or the reduction in the depth in the settling tank.
   c. Per cent of dry solids in sludge drawn.

"Foaming" in Inhoff Tanks

"Foaming" is a term used to describe the condition which develops sometimes in Imhoff tanks, whereby gas, froth and scum rise in the scum compartment or gas vent and carry over the wall into the sedimentation compartment. Besides being unsightly and disagreeable, this condition seriously interferes with the efficiency of the plant. Dark scum and solid material may be carried into the sedimentation compartment and be discharged in the tank effluent. This will cause an unsatisfactory tank effluent and an abnormal load on subsequent treatment units. When foaming occurs, it is frequently advisable to seek the advice of an experienced sanitary engineer. However, there are a few simple treatments which may under certain conditions remedy or improve the condition.

1. Relief may sometimes be obtained by drawing some sludge.
2. Hosing the gas vent area with water under pressure will sometimes help.
3. Cutting the tank out of service if possible and allowing it to rest will sometimes improve the condition.
4. Paddling the foam with long handled hoes is also temporarily effective.
5. Hydrated lime will sometimes correct a foaming condition.
6. The treatment of the raw sewage with chlorine at rates of 3 to 5 p.p.m. will often lessen foaming.

OPERATION AND CONTROL OF TRICKLING OR SPRINKLING FILTERS

Purpose. To stabilize or oxidize, with the aid of bacterial action, the organic matter and to remove the solids which have not been removed by the previous treatment.

Operation.

1. The nozzles should be inspected daily. All clogged nozzles should be cleaned and any broken nozzles replaced. Especially careful attention is required in winter to prevent freezing.
2. The surface of the filter bed should be kept free from vegetable growths.
3. The formation of ponds or "pooling" on the surface of the filter bed may be remedied or prevented by:
   a. Flushing the surface of the filter with a fire hose.
   b. Raking or forking the surface of the filter bed.

c. Punching holes through the top layer of the filter medium with iron bars.
d. Heavy weekly applications of chlorine or chlorinated lime for short periods to the filter bed influent at the dosing tanks.
e. Operation of units may sometimes be improved by putting them out of service occasionally for a period of 12-48 hours except during cold weather.

4. Where the design of the filter bed will permit, the presence of large numbers of filter flies may be controlled by periodic flooding of the filter beds or sometimes heavy doses of chlorine in the sewage applied to the beds.
5. The distribution piping should be flushed periodically.
6. The underdrains should be flushed out occasionally with water hose or other suitable flushing devices, if the filters are so constructed as to make this possible.

Operation Record.

1. Filter bed units in service daily.
2. Filter bed units out of service.
3. Number of nozzles cleaned daily.
4. Putrescibility of the filter effluent as determined by the Methylene Blue test daily.
5. Settleable solids in filter bed effluent as determined by Imhoff cones daily.

SEWAGE AND WASTE DISPOSAL REGULATIONS - Provided by the Louisiana Sanitary Code

1. All sewerage and waste disposal systems must be approved by Louisiana State Department of Health before installation. Approval is also required where systems are augmented, or changed in any way.
2. No sewage, drainage, factory refuse, or any foul or offensive liquid or other material shall be allowed to be emptied into the water of any river, stream, canal, harbor, bay, estuary or sea within the state, except below the low-water mark, and in such manner and under such conditions that no nuisance or public health hazard is created.
3. No privy or water closet shall be built except in accordance with the approved plans of the Louisiana State Department of Health.
4. No privy shall be built or maintained within 20 feet of the line of any street or any house, or within 100 feet of any well, or within 3 feet of the party line of the adjacent lot, except in the rear or side of lots where they abut on the public alley.
5. No privy or water closet shall be built without permit from the municipal or parish board of health.
6. Whenever, in the opinion of the Louisiana State Department of Health, the condition of a privy is not sanitary, the State Department of Health shall order a new sanitary privy built.
7. Privies must be kept clean.
8. No wash water, garbage, kitchen slops or other liquid waste shall be emptied into a privy.
9. No night soil from any person suffering from typhoid fever or other serious intestinal disease shall be emptied into a privy without being disinfected in an approved manner.
10. Every public place where people are employed, live, or congregate, shall be provided with one or more privies; one seat for every 25 or less people, with apartments for sex and color, and shall be provided with proper wash and dressing rooms with an abundance of water, soap and individual towels.
11. Where there is an established system of water works and sewer system, all toilets located on premises within 300 feet of sewer main or lateral shall be connected with the water works and sewer.
12. The contents of no vault, privy, cistern, cesspool or sink shall be allowed to run off into the surface of any ground, or into any street.

REFUSE, GARBAGE, RUBBISH, ASHES - Regulations of Louisiana Sanitary Code

For the purpose of these regulations the following definitions shall apply.

Refuse. The term "refuse" shall include garbage, rubbish, ashes, and all other putrescible and non-putrescible wastes except human sewage, from all public and private establishments and residences.

Garbage. The term "garbage" shall include all putrescible wastes, except sewage and body wastes, including vegetable and animal offal and carcasses of dead animals, but excluding recognized industrial by-products, and shall include all such substances from all public and private establishments and from all residences.

Rubbish. The term "rubbish" shall include all non-putrescible wastes, except ashes, from all public and private establishments and from all residences.

Ashes. The term "ashes" shall include the waste products of coal and other fuels used for heating and cooking from all public and private establishments and from all residences.

Accumulation of Refuse. No owner or lessee of any public or private premises shall permit to accumulate upon his premises any garbage except in covered containers approved by the health officer. Such containers shall be constructed in such manner as to be strong, water tight, not easily corrodible, rodent proof, insect proof, and shall be kept covered at all times except when refuse is being deposited therein or removed therefrom. In case garbage

and other types of refuse are disposed of separately, separate containers may be required by the health officer.

The bodies of vehicles used for the collection and transportation of garbage shall be constructed as to be water-tight and easily cleaned.

Disposal of Garbage and Other Refuse. All disposal of garbage and other refuse shall be by a method or methods specifically approved by the State Department of Health.

1. Provided that said methods shall include the maximum practicable rodent, insect, and nuisance control at the place or places of disposal, and
2. Provided that no garbage shall be fed to hogs unless said garbage has first been heated to at least 212°F. and held there at least thirty (30) minutes in apparatus and by methods approved by the health officer;
3. Provided further, that animal offal and carcasses of dead animals be buried or cremated as directed by the health officer, or shall be rendered at forty (40) pounds per square inch steam pressure or higher, or heated by equivalent cooking.

No house refuse, offal, garbage, dead animal, decaying vegetable matter, or organic waters of any kind shall be thrown upon any street or road.
No garbage dump or place of deposit shall be maintained at any point in the state unless provision is made for prompt and proper disposal of the material deposited. Destruction shall be by incineration, or other effective means to prevent the breeding of flies, harboring of rats, or the creating of a nuisance.
No such refuse, putrescible, decaying animal, or vegetable matter shall be allowed to remain in any house, cellar, outhouse, or on premises in any incorporated or unincorporated village, town or city, or built-up community for a sufficient period to cause a nuisance.
No person shall throw or deposit any garbage, offal, night soil, dead carcasses of animals or filth into, or where same would drain into, any public or private well, cistern or other water supply.
No garbage or waste destruction plant shall be built unless plans for same have been approved by the State Board of Health. No place of disposal for garbage or wastes shall be maintained except by permit of the local board of health.
The handling of garbage and other refuse for the purpose of salvage shall not be allowed except by permission of the local health officer, and under proper supervision.

References - 1. Municipal and Rural Sanitation - Ehlers and Steel
2. Preventive Medicine and Hygiene - Rosenau
3. Louisiana Sanitary Code
4. Sedgewick's Principles of Sanitary Science and Public Health - Prescott and Harwood.
5. Public Health Engineering - Phelps.
6. Water Supply and Sewerage - Steel.

AN ORDINANCE REGULATING THE REMOVAL OF GARBAGE (Prepared by the United States Public Health Service).

Section I. Be it ordained by _______ of the city of ______, that from and after the promulgation of this ordinance, the owner, agent, and occupant of every premise, improved or unimproved, in the city of _________, whereon or wherein garbage shall be created, shall provide a metal, water-tight container or containers, each with a tight-fitting cover, such container or containers to be of such size as to be easily manhandled, and of such number as to receive the garbage accumulation of five days from each such premise, and shall place or cause to be placed such container or containers, for the purpose of having their contents removed, on the sidewalks or open alleys in front or rear of said premises, at the times hereinafter set forth.

Section 2. Be it further ordained, etc., that for the purposes of this ordinance, the city of _______ is hereby divided into _______ garbage districts.

Section 3. Be it further ordained, etc., that for the purpose of this ordinance, the word "garbage" as used in this ordinance shall be construed to mean house and kitchen offal, and all refuse matter not excrementitious liquid, and composed of animal or vegetable substances, including dead animals (except cows, horses, mules and goats) coming from public and private premises of the city, and not destined for consumption as food.

Section 4. Be it further ordained, etc. that it shall be unlawful for such owner, agent, or occupant of any such premise to have, maintain, or keep any garbage on any premise except in such garbage containers as are provided for in section I of this ordinance.

Section 5. Be it further ordained, etc., that such garbage containers shall be kept tightly covered at all times, except when momentarily open to receive the garbage or to have the

contents therefrom removed, as provided for hereinafter.

Section 6. Be it further ordained, etc., that when such garbage container is placed on the outside of any premise it shall be unlawful for any person engaged in the removal of garbage, or for any person to remove the cover from such garbage container, except for the purpose of emptying its contents into a duly authorized garbage wagon or to throw such garbage container on the street or sidewalk, or to injure it in any way, so as to make it leak or to bend it or its cover, as to prevent said garbage container from being tightly covered; and all persons engaged in the removal of garbage shall, after emptying said container, replace the cover tightly on said container.

Section 7. Be it further ordained, etc., that the owner, agent, or occupant of every premise in the city of ______ shall keep separate from their garbage and ashes, tin cans, broken crockery, hardware, old planks, wooden matter, paper, sweeping and other trash, and place same in a sound, substantial vessel or container kept for that purpose, which vessel or container shall be placed on the sidewalk or alley in front or rear of each premise of the city of _____, on _______, provided that such rubbish, other than garbage, may be so placed______ on ______.

Section 8. Be it further ordained, etc., that the provisions of this ordinance shall apply to all public and private markets, as well as all places of business, hotels, restaurants, and all other premises, whether used for business, boarding, or residential purposes.

Section 9. Be it further ordained, etc., that for the purpose of enforcing this ordinance any person living on any premise shall be deemed an occupant, and any person receiving the rent, in whole or in part, of any premise, shall be deemed an agent; that on any premise where construction of any kind is in progress, and where employees or workmen eat their dinners, or lunches, in or about said premises, or scatter lunch or food in or about such premises, the contractor or foreman or other person in charge of such workmen shall be deemed an occupant; and that the person in charge of any market, or stall in any market, shall be deemed an occupant.

Section 10. Be it further ordained, etc.,that it shall be unlawful for any person to pick from or disturb the contents of any garbage containers or vessels, or other containers provided for in this ordinance.

Section II. Be it further ordained, etc., that each day's violation of any of the provisions of this ordinance shall constitute a separate and distinct offense.

Section 12. Be it further ordained, etc., that any person violating any provision of this ordinance shall, on conviction, be punished by a fine of not less than ten ($10.00) dollars nor more than twenty-five ($25.00) dollars, or in default of the payment of said fine by imprisonment ______ for not less than ten (10) days nor more than thirty (30) days, or both, at the discretion of ______ having jurisdiction of the same.

Section 13. Be it further ordained, etc., that any law or ordinance in conflict with the provisions of this ordinance, in whole or in part, be and the same is hereby repealed.

Rural Sewage Disposal

One of the most difficult problems of modern sanitation is to secure proper disposal of fecal matter for rural communities, summer hotels, temporary camps of laborers, tourist camps, summer colonies at beach and mountain, and individual houses in villages and on the farm. It is difficult: (1) Because the necessary structures for fecal disposal are so small and simple that they are often thoughtlessly constructed. (2). Because adequate care of the processes is more or less disagreeable and therefore neglected. (3) Because the inherent dangers are not understood or appreciated. (4) Because the economic status of many rural sections is so low that the construction of satisfactory privies is often too great a financial burden. (5) Because plantation owners and rural landlords are often too recalcitrant regarding the health needs of sharecroppers and tenant farmers. (6) Because collective sanitation is more difficult of administration in areas of scattered dwellings than in urban communities. Besides infection of the ground by pathogenic bacteria, such as cause typhoid fever, paratyphoid fever, dysentery, tuberculosis, and the like, the disposal of human excreta on the ground may infect it with worms such as hookworms, ascaris, and pin worms. In rural communities of the South many of which are found in Louisiana the hookworm problem is of elemental importance in the health of the people. In the rural sections of Washington and St. Tammany Parish, 90% of the school children may have infestations.

The most important sanitary method used to control hookworm infestation in rural areas is the building of sanitary privies. But an idea may be obtained from the following figures of the difficulty of the problem of expecting the farmer to spend money on sanitation:(1) Nearly 1/5 of all southern farm homes in the South have no toilets either indoor or outdoor. (2) Conservative estimates indicate that 4,000,000 (½ of all families) southern families should be rehoused. (3) About 1,831,000 southern families are tenant farmers. These include more than one-half of southern farmer families. About two-thirds of the tenant farmers are white and about one-half of the sharecroppers are white. (4) More than one-third of the tenant families move every year, and in this way the hookworm disease is subject to continuous spreading. (5) Income of the southern farmers is well below an average of $200 annually.

Any honest consideration of the above figures will show the immensity of the problem of introducing even elemental sanitation into southern farm life. Without an alleviation of the economic status of the southern farmer a solution to this problem remains at best uncertain. If ever the sanitarian wishes to find an instance in the practice of public health where the dictum of Dr. Winslow has significant meaning, it is in this circumstance. (Dr. Winslow asserts that one of the functions of public health is "The development of the social machinery which will insure to every individual a standard of living adequate for the maintenance of health".)

There are many different types of privies, for example, the pit privy, the surface privy, the vault privy, the septic privy, the chemical privy, the pail privy, and the bored-hole privy. Of all these, a sanitary pit privy is the safest. It is safe because: (1) The lid is built to be shut except when in use, thus keeping flies out. (2) The vent is screened, preventing entry of flies. (3) The pit is dark if the lid is kept shut and flies abhor darkness. (4) The pit is not deep and it therefore does not extend much below the normal bacterial zone of the soil where the nitrogen cycle may proceed with the self-purification process. Both aerobic and anaerobic bacterial action go on in the pit. (5) The privy is built on the lower slope from springs or wells and far enough away from streams to prevent pollution. A safe distance from springs or wells depends upon the nature of the soil. The distance may be shorter where the soil is sandy and longer where the soil is clayey and the filtration of fluid inadequate to insure safety. In limestone regions where crevices are prevalent or potentially present, distances must be even longer. (6) The earth is terraced around the building to prevent wash water from undermining the structure and carrying away fecal material. (7) Shallow pits will reach the water table less frequently than deep pits and therefore the fluid from the excreta will have been filtered more before reaching the saturation zone of underground water.

IMPORTANT FEATURES IN CONSTRUCTION AND MAINTENANCE OF A PRIVY.

<u>Location.</u> The thing to be considered and one of the most important factors is the location of the privy. The privy should be located so that it will not pollute a domestic water supply. The privy should always be on the down grade from the water supply and at least 100 feet away. Second, it should be housed as a separate unit and conveniently located. Third, the privy should be at least 4 feet from any fence, ditch, or building to insure a proper distance for a mound.

Construction. The type of privy selected should be constructed in accordance with the plans and specifications recommended and approved by the Louisiana State Board of Health, and sound material must be used to prevent deterioration. Details should be given particular attention. See illustrations 1 and 1a. The pit should be dug by the use of a templet so that the curb will fit tightly and prevent caving. The mound should be properly tamped around the building in order to prevent excessive seepage and should be graded with a mound gauge. The seat hole should be properly cut in order to insure comfort to the user. In order to prevent the seat lid from binding against the seat lid strip, at least $\frac{1}{4}$ of an inch space should be left so that the seat lid will remain tightly closed when the privy is not in use. When the ventilator is not sufficiently nailed or an insufficient amount of plastic roofing cement is used, the top of the seat, after a rain, will become moist, thereby causing the privy to frequently be improperly used. Galvanized corrugated roofing is preferable. When concrete sills, slabs, and risers are poured, it is important to see that the proper reinforcing material is used.

Maintenance. The maintenance of a privy is just as important as the construction and is very often overlooked. To maintain a privy the following rules should be followed: The inside of the privy should be kept clean. Use the broom frequently and scrub with soap and water when necessary. A leaky roof should be repaired at once. Plastic cement is recommended. A cupful of kerosene should be poured into the pit each week during the summer months to prevent mosquito breeding. This is especially important when the pit holds water. The earth mounds should be banked up to the floor level around the building at all times. The use of toilet paper prevents the pit from filling up so rapidly. Painting preserves the life of the building and is strongly recommended.

Cesspools. The word cesspool means a pit into which waste water flows. If the pit has permeable sides, it is called a leaching cesspool; if watertight, it is called a tight cesspool. Cesspools are generally covered. Usually the sewage remains in them considerable time so that the bacteria have ample opportunity to act upon organic matter. Bacteria ordinarily found in water require oxygen, and fresh sewage from a house usually contains some of it. On reaching a cesspool the bacteria in the sewage seize this oxygen and it very speedily disappears. The resulting condition is called "anaerobic", and it exists mainly in the lower levels of the cesspools, while aerobic conditions exist in the upper levels. The anaerobic bacteria obtain their oxygen from "combined" oxygen in organic compounds, that is, from the feces, urine and even paper. In doing so, they break down the organic matter, changing some of it into liquids and some into gases. This is called the septic process. Decomposition of such a nature reduces the accumulation of solids in cesspools and prevents the necessity of frequent cleaning. Cesspools often receive, besides the fecal matter, also other domestic wastes. By the combined action of the two types of bacteria (aerobic and anaerobic) a reduction of from 50% to 90% of sludge, or settled solids, is effected.

When soil is sandy leaching cesspools may work satisfactorily. Cesspools usually extend below the bacteria bearing level causing a very slow oxidizing process. In fact a good deal of the organic matter is incompletely oxidized and may become a source of danger if the cesspool is located in clay or limestone earth near drinking water supplies. Leaching cesspools are not desirable, since experience shows that they frequently create undesirable conditions and are potential sources of danger to nearby water supplies. Because of this, the Louisiana State Department of Health does not recommend their use. The tight cesspool is the same as the septic tank, and when constructed with adequate subsurface irrigation, it is recommended as a method of excreta disposal.

Septic Tanks. Septic tanks differ from leaching cesspools in having watertight sides and bottom, in having a definite outlet as well as inlet, in having a more or less constant flow of liquid through the tank, and sometimes in being subdivided into compartments. The biological action is the same as in the leaching cesspool; there is liquefaction and gasification of a part of the organic matter, a small amount of sediment gradually accumulating at the bottom, a considerable amount of scum being lifted to the top by the rising gases. The best method for disposal of the liquid from a septic tank is by a system of subsurface drains. The amount of subsurface tiling would depend upon the nature of the soil-less in sandy soil and more in less porous soil. The subsurface drainage system is layed in the upper 18 inches of the soil where the bacteria may complete the purification process. In order to secure the free flow of the liquid through such a system grease traps are installed between the house and the septic tanks to drain off the fatty materials.

A single-chamber septic tank for single residences should be large enough to hold about 24 hours flow of sewage, and should not be less than four feet deep below the water line. The smallest size septic tank recommended for residences is 450 gal. capacity. For larger groups the flowing through periods may be less. The velocity of the flow should not be greater than one foot per hour, and should be uniform throughout the whole cross-section of the tank. To attain this result, the length should be made greater than the width, and if the tank is more than four feet wide, a weir, or partition extending across the tank, should be placed

as shown on the sketch, to the bottom of the tank without disturbing the scum which forms on the surface of the tank. The weir at the outlet end prevents the surface scum from flowing out of the tank. When the elevation of the tank is such that the sludge may be drained onto drying beds of sand located at a lower level, a sludge drain should be provided in order that the sludge may be withdrawn without throwing the tank out of operation. The floor should be built sloping toward this outlet in order to facilitate the flushing out of the sludge. There is no appreciable difference in the efficiency of open and covered septic tanks, as the surface scum which forms effectively shuts out light and air; but for the sake of appearance and to prevent mosquito breeding, the tanks are usually covered. The covering may be of concrete, flagstone, or even wood, and when the tank is in a lawn, may be sodded over. When sodded over, wood covers should not be used. Manholes should be left in the cover to facilitate cleaning of the tank, or cover should be in movable sections.

Concrete for tank should be 1:2:4 mixture, and should be mixed and placed rather wet. The table on the plan, illustration 2, fig. 1, shows the dimensions for the construction of tanks to serve from 9 to 50 people. The minimum size shown is for 9 persons. The cover of this tank is of reinforced concrete slabs case separately. Fig. 10 shows the details of the distribution box to be used where more than one line of tile is used for the subsurface filtration field.

There is a very common belief that the sewage after treatment in a septic tank is "pure" water or very nearly so. This is absolutely wrong. All a septic tank can do is to change the sewage solids into liquids and gases, and the water dissolves most of the gases. The effluent, that is, the liquid flowing from the tank, may look better than the sewage entering the tank, but it is really just as foul and just as dangerous. The septic tank cannot be depended upon to remove disease germs. If it is possible to discharge the effluent into a nearby stream whose volume is considerably larger than the volume of the effluent, this may be done without causing a nuisance. Since a septic tank does not always completely remove disease germs, the effluent should not be discharged into a stream which is used as a source of drinking water.

Where no stream is available which is not used for drinking water, or which is not large enough to afford sufficient dilution, then further treatment of the septic tank effluent is necessary. Probably the most convenient method for small installations is the "subsurface filtration". This consists of the intermittent application of the sewage to the soil through drains laid below the surface of the ground. By action of certain bacteria, or germs in the soil, the organic matter in suspension and in solution is converted into harmless mineral compounds in very much the same way that barnyard manure is converted into soil when ploughed into the soil. These bacteria require air to provide the necessary oxygen, so it is important that the application of the sewage be intermittent in order that air may have time to replace the foul water in the soil after each application. The distribution of the sewage through the soil is best effected by lines of tile drains laid as shown in Fig. 5, or Fig. 6. The lines are laid with uncemented joints as shown in Fig. 8, about one foot or 18" below the surface of the ground. These lines need not be laid straight, but should follow the contours of the ground, with a fall of 2 or 3 inches per 100 feet. The area required for this treatment depends, of course, on the nature of the soil, and may be determined by allowing one-half foot of pipe per gallon of flow per day in sandy soil, and 1 foot per gallon in fairly dense loam. The table shown in Fig. 7, gives the total linear feet of drain tile required to serve from 9 to 50 persons in various types of soils.

In the dense or clayey soils the absorptive power may be increased by excavating trenches of 2 feet wide and about 18 inches below the proposed grade and filling these in the porous material, such as gravel, shell, cinders or sand. Fig. 9 shows an arrangement suitable for this type of construction. In very sandy soil one line may be enough where sufficient distance is available, but usually it will be better to place the lines 3 feet apart or 8 feet in dense soils. Better results are obtained if two systems of drains are laid and operated alternately a week at a time. In this type of construction, a distribution box similar to that shown in Fig. 10 is necessary to divert the flow to either field. In laying the drains in sandy soil, tarred paper or pieces of pipe of a larger diameter should be placed around the joints as shown in Fig. 8 to prevent clogging. These lines of tile drains should not be laid within fifty (50) feet, and preferably one hundred (100) feet of wells which are used as a source of drinking water supply.

Boggy soils are not suitable for this method of disposal. If the soil holds water for a long period the bacteria which purify the sewage will be drowned out and no purification can take place. Such soils may often be made suitable by a second system of drains, not connected to the drains from the tank, but laid so as to dry out the area as shown by the "secondary system" of Fig. 5.

For large installations a dosing tank and some form of dosing device should be used which will automatically discharge the sewage into the treatment field at intervals. For small

families the dosing tank is not essential, but better results will be obtained if one is used, particularly in unfavorable soils.

Where the subsurface distribution system has more than one line, a distribution box with sufficient number of outlets should be provided near the head of the distribution lines in order to equalize the flow in the different lines. Plugs should be provided for the purpose of shutting off at this chamber the flow in any part of the distribution system. All outlets from this equalizing chamber should have the same grade for a distance of several feet in order to prevent some taking more water than others. The fall to any laterals which may be lower than others should be made beyond this distance. The drains between the house and the septic tank and between the tank and the distribution box should not be less than 4 inches in diameter, and should be laid with tight joints to a grade of not less than one foot in a hundred. If waste from the kitchen sink enters the septic tank, then a grease trap should be provided as shown in Fig. 4. The grease trap should be located as shown in the residence sketch of Fig. 5. While such installations may work for years, the drains of the subsurface distribution system sometimes become clogged and require cleaning. This is rarely much of a job, as the pipes are not laid very deep.

Where the soil is suitable, this system of subsurface disposal may be used for dwellings, schools, small institutions or other places having a daily flow of less than two thousand gallons. For greater quantities of sewage or where the soil is dense, it is best to use some form of filter bed. The design presented here is for dwellings or places up to 50 persons. Plans providing for the sewage disposal for groups of 20 persons or above, particularly those for schools, should be first submitted to the State Department of Health for approval before construction.

In many localities throughout Louisiana there are cesspools with porous bottoms or with overflows to street gutters and surface drains. The first of these types is dangerous, because the pollution enters the soil at a depth below the upper layers of the soil where are found the nitrifying bacteria which carry on the work of oxidation of waste organic matter. Thus, the sewage instead of being oxidized or purified, by seeping into the soil, gradually extends the zone of pollution and may endanger the purity of wells a considerable distance away. With the second type, there is a danger that disease germs may be discharged onto the surface of the ground or into shallow ditches. As the effluent of the tank is putrescible, it frequently causes a nuisance by collecting in stagnant pools and giving rise to very objectionable odors. For small families in localities where the soil is sufficiently porous, these insanitary and dangerous cesspools may be remodeled by making them water tight and by allowing the overflow to filter through the soil through lines of tile drains described above.

Wherever a community is fortunate enough to be provided with a sewerage system, the septic tanks should be abandoned and the property connected to the public sewerage system. The Louisiana State Sanitary Code requires that all homes within 300 feet of a sewerage system shall connect to the system. The discharge of overflows from septic tanks or cesspools into street gutters or surface ditches is also prohibited by the State Sanitary Code.

There are other methods of rural excreta disposal, but in order to get the best sanitary results, we must try to use the most sanitary methods as described above.

Sewage disposal in camp sites should not differ from those methods generally used in rural sanitation.

Ground Water Pollution. The pollution of ground water by privy or cesspool wastes and the extension of the pollution to wells, springs and other water supplies is a problem of utmost importance to the sanitarian. A number of experiments has given us the following information:

The speed of water moving along the more or less horizontal surface of an impervious stratum is dependent on: (1) The slope of the impervious stratum (hydraulic gradient). The hydraulic gradient is measured by the relation of the height of the slope to the length of the horizontal base of the slope. Thus, a slope formed by a height of one foot and a horizontal base of 100 feet is called a 1% slope or hydraulic gradient (H.G.). (2) Porosity of the earth. (3) Arrangement and interconnection of interstices in the ground.

The velocity of underground water is described by the following table:

Type of Earth	Grain Size in MM.	Average Velocity - Ft. per Day - 1% H.G.
Silt-fine sand	.005 to .25	.065
Sand stone	.25 to .50	1.16
Coarse sand	.50 to 2.0	6.33
Gravel	2.0 to 10.0	30.00

When in the ground, bacteria will continue to live, dependent on the favorability or unfavorability of its environment, that is, the temp., the pH, the food supply, etc. The ground is usually unfavorable for pathogenic bacteria. Typhoid bacilli will probably live 70 days in wet soil at a pH near neutral. Paratyphoid and dysentery bacilli may live somewhat longer. Coli bacilli were found to live buried in the soil for a period of over 3 years. Therefore the longer it takes contaminated water to trickle through the soil the safer it becomes. Experiments show that if a privy is sunk below the water table, the pollution may travel as far as 232 feet horizontally along the water table. They show also that the bacteria move only in the direction of the flow of the water along the water table line and not along the whole zone of saturation.

Percolation. We see, then, that the finer the porosity of the soil, the more effective it is as a filter of ground water. The porosity of the soil tends toward two extremes, very large and very small pores. In either extreme the soil becomes less and less effective and even useless. The very large pores of large gravel strata are ineffective as filters due to their inability to filter out small particles. The very small pores of lime stone strata are ineffective as filters on account of their practical imperviousness. Between these two extremes we find a range of porosity that is suitable for filtration or as we will henceforth call the "percolation" of water. The ability of water to percolate through the earth determines the amount of tiling to be used in a subsurface sewage drainage system. Experience has given us the following scale to determine the amount of tiling necessary. This scale is based on the classification of the soil.

Type of Soil	Tiling Requirements
Coarse Sand	12 feet per person
Fine Sand	20 " " "
Sand and Clay	60 " " "
Clay and Sand	80 " " "
Heavy Clay	Unsuitable

The above test depends of course too much on the personal factor of who it is that classifies a particular soil. A more accurate, more logical and more practical method of determining the amount of tiling required is based on the time it takes for water to percolate through the soil. This is an entirely objective method and is known as the "percolation test". It is described as follows: A hole one foot square is dug to depth equal to that at which it is proposed to lay the tile drain. The hole is filled with water to ensure thorough moistening of the soil. The water is allowed to seep away. Then while the bottom of the hole is still moist, water is again poured in, but this time to a 6 inch depth. The time that the water level falls one inch is then observed. The approximate length of tile required per person, based upon a trench 1 foot wide and a sewage flow of 50 gallons per person per day, is given by the following table:

Time Required for Water to Fall One Inch	Approximate Length of 4 Inch Tile Required when Sewage Flow is 50 Gals. per Person per Day
1 minute	12 feet per person
2 "	15 " " "
5 "	20 " " "
10 "	30 " " "
30 "	60 " " "
60 "	80 " " "
Over 60 minutes	Unsuitable

If the sewage flow is less than 50 gallons per capita per day, proportionate reduction in the length of tile required per person may be made. Some reduction in lengths required is also permissible if trenches wider than 12 inches are used.

References: (1) Report on Economic Conditions of the South - National Emergency Council
(2) Preventive Medicine and Hygiene - Rosenau
(3) Municipal and Rural Sanitation - Ehlers and Steel
(4) Essentials of Field Sanitation - Medical Field Service School
(5) Sanitation of Camps and Stations - Supt. of Documents
(6) Louisiana State Health Regulations
(7) Rural Water Supply and Sewage Disposal Systems - New York State Department of Health

CORRECT AMOUNT OF MATERIAL NEEDED FOR ONE SANITARY PIT PRIVY

12 Pcs.	1 x 10	8'	#3 S4S	80'	------------ For Curb
1 "	1 x 10	14'	#3 S4S	12'	- For Roof Sheathing
3 "	2 x 4	12'	#2 S4S	16')	- For Complete Framework
10 "	2 x 4	10'	#2 S4s	67')	
2 "	1 x 4	14'	#2 S4S	9')	- For Vent
1 "	1 x 6	16'	#2 S4S	8')	
3 "	1 x 6	12'	#2 S4S	18'	----For Roof Band
15 "	1 x 8	14'	#2 S4S	93'	Dressed - For House
1 "	2 x 10	5'	#1 S4S	8')	
1 "	5/8 x 4	7'	#1 Ceiling	2')	---For Seat
1 "	8430	6'	Blind Stop	6L')	

2 Sacks Portland Cement - - - - - - - - - - - - - -)
10 Cu. Ft. Gravel - - - - - - - - - - - - - - - - - -) ---For Concrete Slab, Riser
7 Cu. Ft. Sand - - - - - - - - - - - - - - - - - -) and Sill

1 # Lead Head Nails
2 Lbs. 6d Nails
7 Lbs. 8d Com. Nails
4 Lbs. 10d Com. Nails
½ Lb. #3d Com. Nails
1 Pair 6" Strap Hinges
3 Pcs. 6' x 26" Galvd. Corg. Roofing

1 Lb. Plastic Cement
1 Pc. 6" x 30" Copper Screen Wire
4 Bolts 1/4 x 4
1 Box 3/8 Corg. Fasteners
4 Lin. Ft. #9 Gauge Wire Fencing for Reinforcing
4 Pcs. 1/4" x 52" Reinforcing Rods

CORRECT AMOUNT OF MATERIAL NEEDED FOR ONE DOUBLE PIT PRIVY

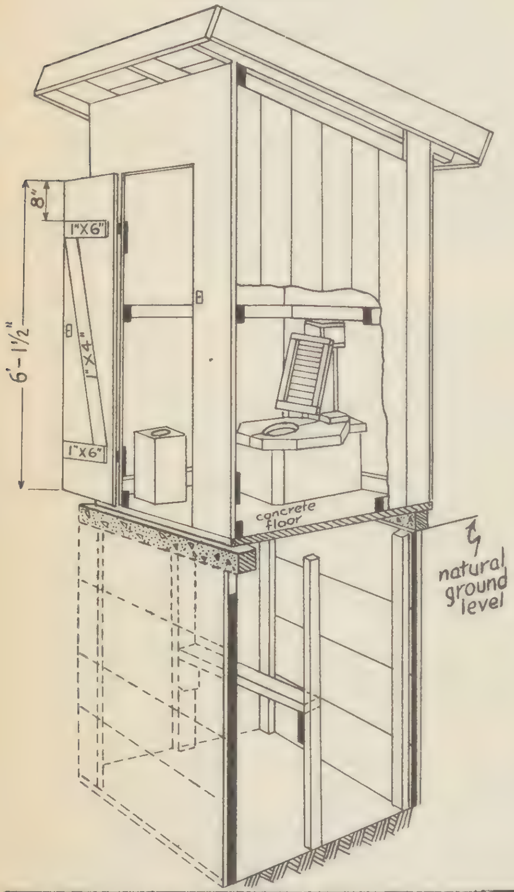
12 Pcs.	1 x 10	10'	#3 S4S	------ For Curb
1 "	1 x 10	14'	#3 S4S	--- For Roof Sheathing
5 Pcs.	2 x 4	12'	#2 S4S)	------- For Complete Framework
10 Pcs.	2 x 4	10'	#2 S4S)	
3 Pcs.	1 x 4	14'	#2 S4S)	------- For Vent
2 Pcs.	1 x 6	16'	#2 S4S)	
4 Pcs.	1 x 6	14'	#2 S4S	------ For Roof Band
20 Pcs.	1 x 8	14'	#2 S4S	------ Dressed - For House
2 Pcs.	2 x 10	5'	#1 S4S)	
2 Pcs.	5/8 x 4	7'	#1 Ceiling)	--- For Seat
2 Pcs.	#8430	6'	Blind Stop)	

3 Sacks Portland Cement - - - - - - - - - - - - - -)
1/2 Yd. Gravel - - - - - - - - - - - - - - - - - - -)---For Concrete Slab, Riser
1/3 Yd. Sand -) and Sill

2 Lbs. Lead Head Nails
4 Lbs. 6d Com. Nails
12 Lbs. 8d Com. Nails
1/2 Lbs. #3d Com. Nails
7 Lbs. 10d Com. Nails
2 Pairs 6" Strap Hinges
2 Lbs. Plastic Cement

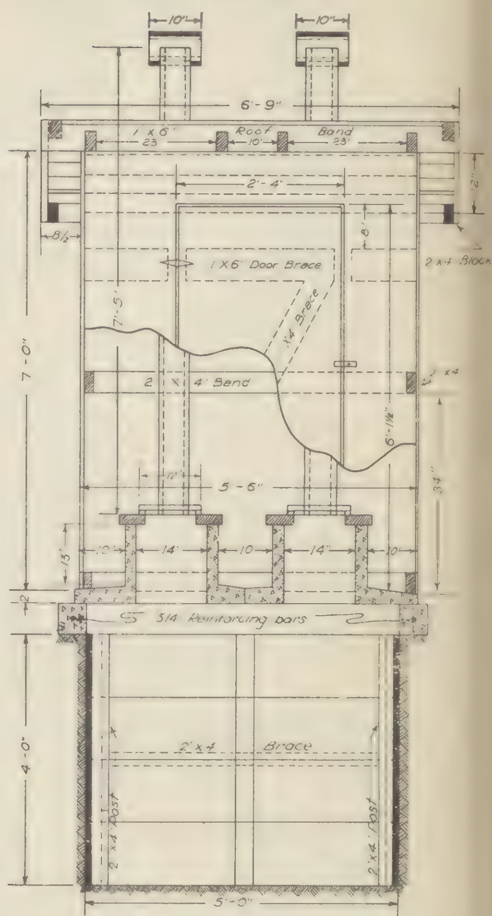
2 Pcs. 6" x 30" Copper Screen Wire
8 Bolts 1/4 x 4
1 Box 3/8 Corg. Fasteners
4 Pcs. 6' x 26" Galvd. Corg. Roofing
5 Lin. Ft. #9 Gauge Wire Fencing For Reinforcing
4 Pc. 1/4" x 63" Reinforcing Rods.

ILLUSTRATION 1



SANITARY PIT PRIVY WITH URINAL
Recommended for Rural Homes
by
LOUISIANA STATE BOARD OF HEALTH

ILLUSTRATION 1-A



Front view of Girls Double School Privy
Curb, Risers, Etc.

SANITARY PIT PRIVY
LOUISIANA TYPE
RECOMMENDED FOR RURAL HOMES & SCHOOLS
BY
LA. STATE BOARD OF HEALTH

SEPTIC TANK

TOP VIEW

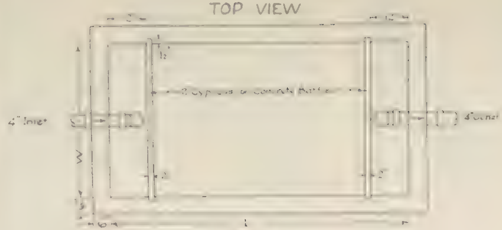


Fig. 1

SECTION THRU CENTER

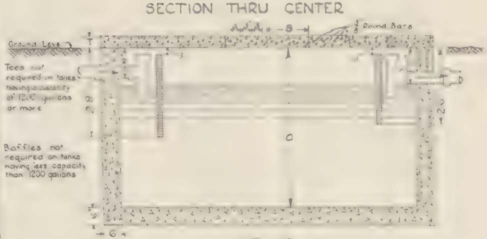


Fig. 2

TABLE OF SIZES OF SEPTIC TANKS

Number of Persons	Septic Tank Dimensions: Capacity Gallons	W	L	D	Thickness of Concrete: Cover Slab No.			Walls	Bottom	Approximate Quantities of Materials Required: Sacks Cement	Cu. Yds. Sand	Cu. Yds. Gravel
Up to 9	500	2 9	6 1	5 0	8	12	3	6	6	16	1½	2½
10 to 14	[illegible]	3 0	7 0	5 2	8	[illegible]	4	6	6	17	1¾	2¼
15 to 20	840	3 6	8 0	5 2	9	12	4	6	6	20	2	3
21 to 25	960	4 0	8 0	5 0	Solid*		4	6	6	21	2	3¼
26 to 30	1200	4 6	9 0	5 0	"		5	[illegible]	6	29	2¾	4½
31 to 35	1400	4 [illegible]	[illegible]	[illegible]	"		5	8	6	31	3¼	[illegible]
36 to 40	1600	4 6	10 0	5 9	"		5	8	6	[illegible]	3½	5¼
41 to 45	1780	5 0	[illegible]	5 9	"		5	9	6	[illegible]	4¼	[illegible]
46 to 50	2000	5 0	10 8	6 0	"		5	9	6	[illegible]	[illegible]	[illegible]

Note: For dry sand and gravel use [illegible] gallons of water per sack of cement; for moist materials use [illegible] gallons. Vary sand and gravel to give good working mixture. Avoid stiff or sloppy mixes.

*Provide Manhole for Cleanout on Solid Slabs.

Fig. 3

GREASE TRAP

Fit Cypress Cover into Top

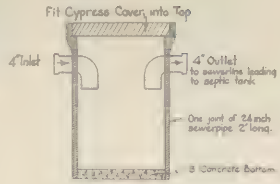


Fig. 4

TYPICAL INSTALLATION

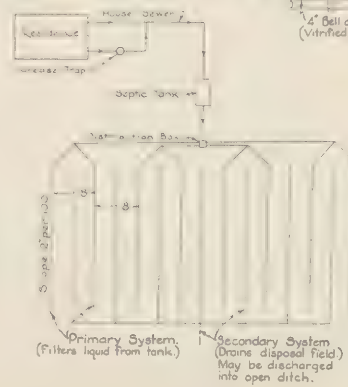


Fig. 5

TABLE OF LENGTHS FOR DISPOSAL FIELD

Number of Persons	Total Linear Feet of 4" Drain Tile: Sandy Soil	Medium Soil	Clayey Soil
Up to 9	[illegible]	[illegible]	500
10 to 14	[illegible]	350	750
15 to 20	250	500	[illegible]
21 to 25	[illegible]	[illegible]	[illegible]
26 to 30	[illegible]	700	[illegible]
31 to 35	[illegible]	[illegible]	1700
36 to 40	450	[illegible]	2000
41 to 45	500	[illegible]	[illegible]
46 to 50	600	1200	2400

Fig. 7

DETAIL OF TILE CONSTRUCTION

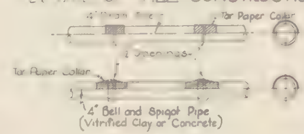


Fig. 8

DISPOSAL FIELD FOR SMALL INSTALLATIONS

Fig. 6

SECTION OF TRENCH

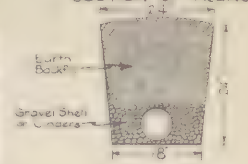


Fig. 9

DISTRIBUTION BOX

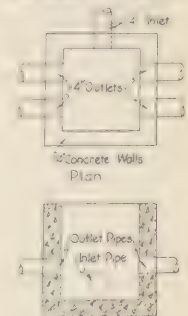


Fig. 10

SEPTIC TANK & DISPOSAL FIELD FOR SUBURBAN HOMES

LOUISIANA STATE BOARD OF HEALTH
BUREAU OF SANITARY ENGINEERING

OCTOBER 1940

Plumbing

A plumbing system of a building embraces the pipes, connections, fixtures, devices and sanitary fittings included in supplying a house with a water, drainage and gas service. From a public health point of view the plumbing associated with these three systems, i.e. water drainage and gas, is very important but the concern here will be entirely with the water and drainage systems since they bear on the problem of communicable disease spread and prevention.

The plumbing system of a building includes the water service pipe, the water supply distributing pipes, the fixtures and fixture traps, the soil, waste and vent pipes, the building drain and building sewer and the storm water drainage, with their devices, appurtenances and connections, all within or adjacent to the building.

The house plumbing is the beginning of the town drainage system and the termination of the water-distributing system. It brings the water supply into the building and collects the waste materials from toilet, wash bowl, bath tub, kitchen sink, laundry tray and other fixtures. In combined systems it also carries away the rain water from roof and yard areas.

The main features of sanitary plumbing are:

1. The Vertical Pipe Lines
   a. One or more vertical drainage stacks - these extend from below the lowest fixture to the roof, and collect the wastes from plumbing fixtures.
   b. One or more vertical water supply pipes - these arise from the under-ground lead-in coming from the street main and serve to distribute the water to various levels in the building.
2. The Horizontal Pipe Lines
   a. The house drain which runs horizontally under the ground and receives the discharge from the drainage stack, conveying it to the house sewer which empties into the street sewer.
3. The Lead-in Water Line from the street water main which supplies vertical water pipes in the house.

Nomenclature -

Soil pipes are those carrying the discharge of water-closets or urinals.

Waste pipes are those carrying the discharge of any fixture except water-closets or urinals.

Stack is a general term for any vertical line.

Soil stacks are those vertical lines carrying the discharge of water-closets or urinals.

Vent pipe is any pipe provided to ventilate a house drainage system and to prevent trap siphonage and back pressure.

Local ventilating pipe is one through which foul air is removed from a room or fixture.

A trap is a fitting or device so constructed as to prevent the passage of air or gas through a pipe without materially affecting the flow of sewage or waste water through it.

Trap seal is the vertical distance between the crown weir and the dip of the trap.

The main of any system of horizontal, vertical, or continuous piping is that part of such system which receives the wastes, vent, or back vents, from fixture outlets or traps, direct or through branch pipes; or that part of a water supply system which supplies branch pipes.

The branch of any system of piping is that part of the system which extends horizontally at a slight grade, with or without lateral or vertical extensions or vertical arms, from the main to receive fixture outlets not directly connected to the main, or to supply water fixture outlets.

House drain is that part of the lowest horizontal piping of a house-drainage system which receives the discharge from soil, waste, and other drainage pipes inside the walls of any building and conveys the same to the house sewer.

House sewer is that part of the horizontal piping of a house drainage system extending from the house drain to its connection with the main sewer or cesspool and conveying the drainage of but one building site. It extends to within 5 feet of the foundation wall of the house.

Plumbing fixtures are receptacles intended to receive the discharge water, liquid, or water-carried wastes into a drainage system with which they are connected.

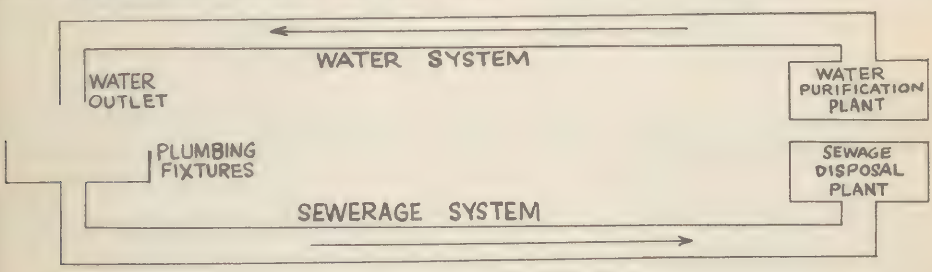
Cross-connection is a connection between the distribution system of a public or private, potable water supply and a private or secondary nonpotable supply.

Interconnection is any connection to a distribution system of a public or private potable water supply, other than one with a private or secondary nonpotable supply through which contamination may enter the potable water-supply lines.

Back-siphonage is the phenomenon characterized by a reversal of flow in a plumbing system, fixture, or appliance, which is caused by the development of a less-than-atmospheric pressure in the supply line to the installation.
Vacuum or partial vacuum is where an absolute pressure of less than one atmosphere (14.7 lbs. square inch at sea level) exists in a water carriage line.
Submerged inlet is any unrestricted water-supply connection or inlet to a plumbing fixture, appliance, or installation, other than a direct enclosed connection, which is located at a distance of less than twice the diameter of the inlet above the highest possible water level of the fixture, appliance, or installation.
Highest possible water level is the highest point to which water may rise in a fixture should the drain from the fixture become clogged. In an open fixture this is the same as the spill-line.

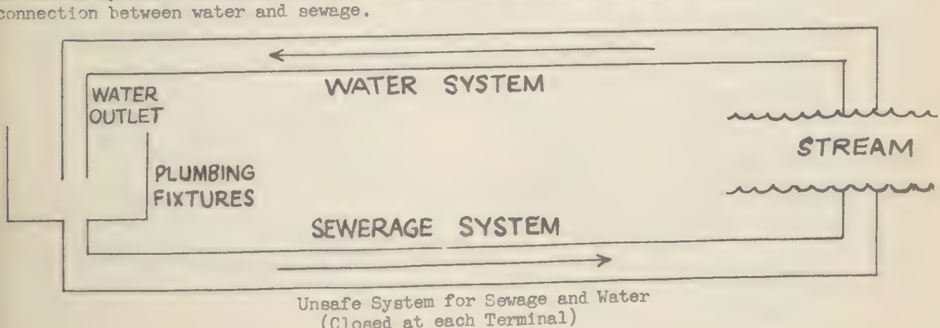
CONDITIONS WHICH MAY CAUSE CONTAMINATION OF THE WATER SUPPLY BY WASTE WATERS

In any building there is both the beginning of the sewerage system and the termination of the water supply distributing system. Sewage, being water-carried body wastes, must at some point receive the water of which it is composed. It is because water and waste must have a common meeting place inorder to become sewage, that greatest caution must be exercised lest the continuous cycle of incoming water and outgoing sewage is not reversed. The reversal of this cycle is possible due to the peculiar character of water and sewer systems. The water system is a closed system of pipes from the water main at the purification plant to the faucet in the home. The sewer system is a closed system of pipes from the waste receptacle to the sewage disposal plant, or sewage receiving body of water. More or less it can be said that where one system begins the other ends, and where one ends the other begins. Because of the close relationship of these two systems, they may even be considered as two parts of one large system. The sewerage part as the outgoing phase and the water distributing part as the in-going phase. In order for this system to function adequately in so far as health is concerned, it becomes imperative that the direction of the cycle does not become reversed. The sewage disposal end must be guarded against sewage becoming water supply by treating sewage at disposal plants and treating water at purification plants. The water consuming end must be guarded against sewage entering the water supply. This could happen by the installation of plumbing which would allow the back-flow of sewage into the water supply. The two systems must be kept open only at their terminals, since if the two systems joined each other at their terminals into a closed system any material increase in the pressure in the sewerage system or decrease in the pressure in the water supply system could cause a reversal in the flow of the liquid and a contamination of the water supply.EXAMPLES:



Safe System for Sewage and Water
(Open at each Terminal)

In such a system a reversal in flow would not contaminate the water since there is no direct connection between water and sewage.



Unsafe System for Sewage and Water
(Closed at each Terminal)

In such a system a reversal in flow would draw sewage from the waste receptacle into the water supply system. Where the water and sewage remained untreated the system could be considered closed since the water supply system would draw in untreated sewage.

Water purification and sewage treatment will be discussed under other appropriate headings. In general, the main source of water contamination is inadequate plumbing which is unable to prevent the back flow of sewage into the water system when the pressure conditions within the pipe lines become reversed. To understand how such back flows are developed it becomes necessary to understand some of the principles of hydraulics. Hydraulics is the science which treats the mechanical movement of water. In plumbing the movement of water in pipes is due to pressures and counterpressures, or increased pressures and partial vacuums. Included here, also is the principle of siphonage.

A vacuum means that air or gas is, for practical purposes, absent. Under normal conditions there is a certain amount of atmosphere surrounding the earth. Since atmosphere is a combination of various gases, it has weight. Gases are composed of moving molecules; therefore, the weight of the gases is due to their mass and their amount of movement. For example, the weight of a stationary baseball may be 8 ounces, but when hurled at a high speed it may have a force value equivalent to 50 pounds. If one had the instruments for measuring the weight of the atmosphere on each square inch of earth surface at sea-level, it would be found to be 14.7 pounds. The higher the land, the less the weight. This pressure of 14.7 pounds to every square inch at sea-level is called one atmospheric pressure. On most pressure gauges, one atmospheric pressure is calibrated to read zero. If the air were completely withdrawn from a long vertical pipe and the lower end immersed in water, the water would rise in the pipe to a height of about 34 feet and no further. This means that the atmospheric pressure on the surface of the water is great enough to force the water into the pipe to a level of 34 feet.

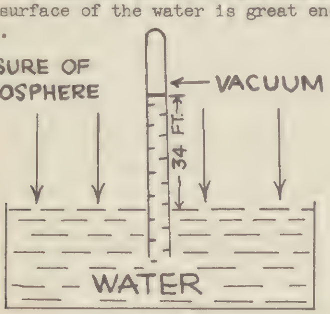


Figure II

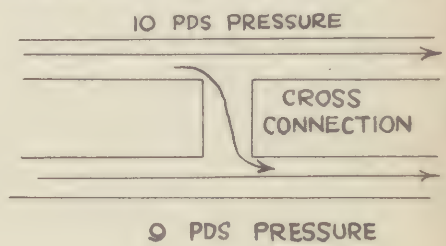


Figure III

If only part of the air were withdrawn from the pipe, then the water would rise less than 34 feet. Thus the degree of the vacuum or partial vacuum would determine how high the water would rise. If this experiment were done on the top of a high mountain, the atmospheric pressure would be less and, therefore, the water would not rise 34 ft. into the pipe.

<u>Water will Flow in the Direction of Lesser Pressure</u>. If two water bearing pipes were connected, one with a water pressure of 10 lbs. and the other with a water pressure of 9 lbs., the water from the 10 lb. pressure would flow into the pipes with 9 lbs. pressure. Now, if the water in one of these pipes were flowing at a very fast rate while the other flowed at a lesser rate of speed an opposite phenomenon would occur. The water from the pipes where the flow is slower would flow into the pipe where the flow is very fast. This would be due to the fact that as the swift current flows past the opening of the cross-connecting pipe it would pull the water or air from this opening with it, tending to cause a vacuum in the cross-connecting pipe. In this manner, the pressure in the cross-connecting pipe would become less than the water in the pipe with the slower flow of water, and the water would then flow in the direction of less pressure.

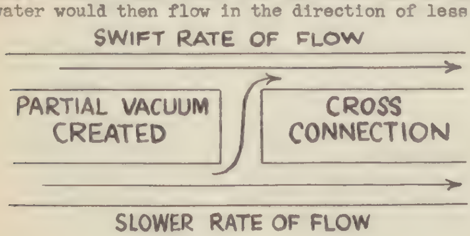


Figure IV

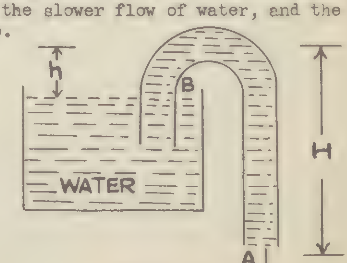


Figure V

Another principle which must be observed is that known as siphonage. If a bent tube is filled with water and one end is introduced into a vessel of water while the other end is open and held at a lower level than the surface, the liquid will escape through the lower end of the tube. The surface (B) of the water in the vessel and also the open end of the tube (A) are subjected to the same atmospheric pressure, but the weight of the water in the short end is less than the water in the long end, therefore the weight or pressure which is effective in causing the water to flow out at A is height H minus height h. In other words, if the atmospheric pressure on surface B and on surface A were 12 lbs. and weight of the water in the short column 1 lb. and in the long column 2 lbs., then the effective pressure in the short column would be 12 minus 1, or 11 pounds. (Figure V)

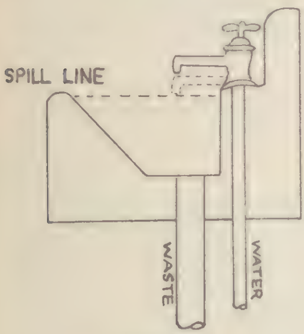


Figure VI

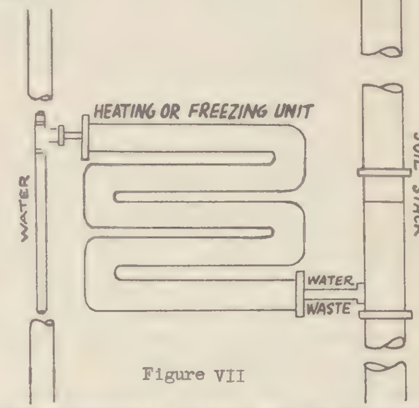


Figure VII

If the pressure in the water line becomes less than atmospheric pressure and if the water inlet is below the spill line, the waste water in the lavatory will be sucked into the water line. The water inlet should be at least one inch above the spill line. This is an example of back siphonage. (Figure V1)
In large buildings or industries where large quantities of water are used, the flow through the water line may be so great that partial vacuum may be produced in any cross connection or interconnection. For example as shown in the above interconnections, Figure VII, resulting in the suction of waste water or sewage into the water line.

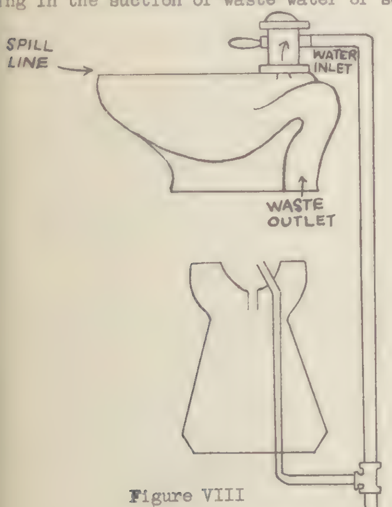


Figure VIII

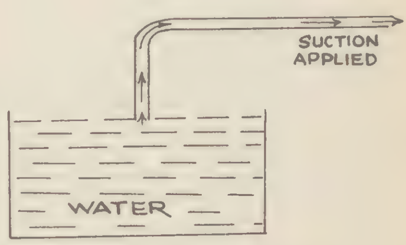


Figure IX

Such a connection between a water closet and drinking fountain may simulate a siphon if the the water closet becomes stopped up and the water in the bowl reaches the water inlet,while the pressure in the water line decreases to less than atmospheric pressure. The reversal of flow is known as back-siphonage. (Figure V111)

Pressure in the long column would be 12 minus 2, or 10 lbs. Thus the pressure in the short column is one lb. greater than in the long column and the water would flow from higher pressure to lower pressure.

A principle which probably does not often operate in a plumbing system, but which may be a hazard under certain conditions is one based on suction. If suction is applied to a pipe whose opening is near to the surface of a liquid, the liquid may be drawn into the pipe. Open end pipes should therefore be an inch or more above the level of a liquid surface. (Figure 1X)

The foregoing principles of hydraulics must be understood in order to clearly comprehend the safeness or the liability of plumbing fixtures, devices, tanks or other equipment. Hydraulics is the science which treats the mechanical movement of water. In plumbing, the concern is mostly with the movement of water in pipes and the pressures, counterpressures, vacuums and partial vacuums related thereto.

CONDITIONS WHICH MAY CAUSE CONTAMINATION

These conditions can be broadly divided into three classes:
1. Decreased pressure in the water distributing system.
2. Increased pressure in the drainage systems.
3. Defects in structure of fixtures, appliances and equipment
   (a). Leaks, (b) Open top water supply and storage tanks, (c.) Inadequate heating facilities in sterilizing equipment.

These may all operate at the same time. More specifically these conditions may be described as follows:

Those due to development of negative pressure in water distributing line -
1. Water pressure fluctuates for various reasons and may become negative at any point in the water-supply distribution system.
2. A water inlet which terminates below the spill line of a receptacle may at some time become submerged, thus making possible the back-siphonage of the contents of the receptacles or fixtures into the water pipe.
3. A partial vacuum may be created when steam condenses in a closed vessel.
4. Many water closets and certain other fixtures that are equipped with flushometer valves constitute a direct connection between the water supply and the plumbing drainage system and may permit back-siphonage of the contents of the fixtures unless they are equipped with effective vacuum breakers.

Those due to the building up of positive pressure in the drainage system -
1. Pressures may develop in street sewers, building drains, and waste pipes because of stoppage, air locks, or overloading.

Those due to leaks -
1. Water pipes may leak and pollute sterile water, utensils, bandages, and other sterile objects.
2. Valves and checks, even though closed, may leak, and are therefore not equivalent to a complete physical break.
3. Pipes that carry sewage, contaminated water or poisonous liquids, are occasionally located in such a way that leakage from them may cause contamination of water, food, dishes, cutlery, and the like.

Those due to inadequate heating facilities in sterilizing equipment -
1. Another condition not associated with water movement which may cause contamination is when water in hot-water lines may not always be maintained at temperatures high enough to sterilize water.

COMMON CAUSES OF A PARTIAL VACUUM

1. Shutting off a portion of a system and draining it for repairs.
2. A break which drains portions of a piping system.
3. Heavy demands, causing water to be drawn from higher elevations of a piping system.
4. Too many outlets on an undersized piping system.
5. Fire engines pumping from the system, or pumps in the system used for booster purposes which reduce pressure below normal.
6. Draining the pipe lines for cleaning and flushing them.

PRINCIPLES TO BE OBSERVED IN THE DESIGN OF TANKS, RECEPTACLES, EQUIPMENT AND PLUMBING FIXTURES.

1. Every plumbing fixture and its connections with the water-supply distribution system and the plumbing drainage system should be such that contaminated or unsafe water, mixtures

or substances, cannot flow, be forced, drawn or otherwise introducted into the water-supply distribution system.

2. The water-supply pipe should be brought separately to the fixture so that under no condition will any portion of the supply pipe be in contact with the waste in the fixture or waste coming from the fixture. No portion of the fixture should be used to convey water to the inlet end of a fitting, faucet or other inlet through which water is supplied to the fixture unless the waterway is sufficiently high to prevent back-siphonage of waste into the water-supply distribution system.
3. All water-supply outlets should terminate at a point above the spill line at a distance which is great enough to prevent back-siphonage of waste into the water-distribution system. Violent agitation of contents of vats, tanks and other equipment in industrial plants may submerge inlets which under normal conditions would afford ample clearance to prevent siphonage.
4. In addition to the water supply, there are certain fixtures and equipment such as dish-washing machines, soda fountains, sterilizers, food storage boxes, autoclaves, etc. which should be protected from contamination that may come through the drain or waste connection to the sewer. The waste pipe should not connect directly to the sewer, but should terminate above the spill line of the fixture or receptacle into which it discharges. Certain other fixtures such as instrument sterilizers, pan sterilizers, water sterilizers, should have independent drain, or waste pipes, and/or adequate vacuum breaker on the water supply.
5. When a safe water supply is being distributed to an institution or industry, where hazards exist that may endanger the supply, the system should be protected from contamination by carrying the water service to a receiving reservoir which is properly constructed and is above grade. The water service pipe should terminate at least six inches above the spill line of the receiving reservoir. Because of such potential hazards as flooding with sewage or with water that may contain dangerous wastes, the amount of piping and outlets, cisterns, storage tanks and control tanks used in connection with drinking water supplies, should be located as little as possible in basements, tunnels, or other space below ground level.
6. Care should be taken in relation to plumbing installations such as locating sewer and drain lines over the freezing compartments of ice machines, over water tanks, meat blocks, food containers, utensils that are used in the preparation and the serving of food.

PLUMBING FIXTURES AND INLET DESIGN COMMONLY RESPONSIBLE FOR PLUMBING HAZARDS

1. Flush Valve - Satisfactory mechanical operation of most flush valves depends upon the maintenance of a continuous positive pressure in the water supplies. Should a vacuum occur in the supply line, the flush valve may open and back-siphon the fixture contents through the siphon-jet opening.
2. Flush Tank - To insure quietness of operation the inlets to flush tanks are almost always submerged. If the ball cock leaks or if it is opened for the purpose of filling the tank during a period of vacuum in the supply line, a portion of the tank contents may be back-siphoned carrying with it any pollution which may be in the tank. There are three types of flush tanks in general use for toilets - (a) The tank built integral with the toilet bowl, (b) The low tank, separate from the bowl, the outlet of which is usually two or more inches above the top of the bowl, and (c) The high tank, most often used with a wash-down bowl. With the integral tank there is so little difference in elevation of water in the tank and bowl that only partial stoppage in the latter will permit a mixture of the bowl and tank water. Such fixtures should therefore be considered deficient unless the tank-water inlets are adequately protected against back-siphonage.
   Low tanks are also subject to pollution by a mixture of the bowl contents with the tank water.
   The possibilities of back-siphonage from a high tank to supply lines are not as great as in the case of the low and integral type tanks. High tanks are usually open and consequently are subject to air pollution but other possibilities of contamination exist, such as by vermin or leakage from pipes passing above the uncovered tanks.
3. Lavatories, Bath Tubs, and Laundry Trays - A large percentage of these are supplied thru submerged inlets. Although overflow outlets may be some distance below the rim, this cannot be depended upon. Conditions may be obtained where back-siphonage may occur.
4. Soda Fountains, Sinks, Bidets, Aspirators, and Dental Cuspidors present more hazards than most of the fixtures with submerged inlets. The inlets to soda fountain sinks and bidets are most commonly located at the bottom of the fixtures and are continuously submerged. Aspirators are suction pumps operating on the principle described in Figure lV. Protection against back-siphonage must be provided.
5. Industrial Equipment - The most common of these appliances are laundry and dishwashing machines. In almost all of these installations, the inlets are either submerged or become submerged when the machine is in operation. Back-siphonage is the hazard.
6. Hospital Fixtures - Bedpan washers and sterilizers may have a portion of their contents drawn into the water-supply line when a vacuum exists in the latter. Back-siphonage may

occur in sterilizers during the cooling period and condensation of steam. A partial vacuum is created in the sterilizer and if it is connected to the drainage system may back-siphon water from the drainage line.

7. Drinking Fountain - There are only a few fixtures in which contamination and disease may be spread without occurrence of a vacuum. Foremost of these is the drinking fountain. A joint report of the committee on plumbing of the American Public Health Association and the conference of state sanitary engineers outlines the essential factors necessary for the construction of a safe, sanitary drinking fountain which are as follows:
   a. The fountain should be constructed of impervious material, such as vitreous china, porcelain, enameled cast iron, other metals, or stoneware.
   b. The jet of the fountain should issue from a nozzle of nonoxidizing, impervious material set at an angle from the vertical such as to prevent the return of water in the jet to the orifice or orifices from whence the jet issues. The nozzle and every other opening in the water pipe or conductor leading to the nozzle should be above the edge of the bowl, so that such nozzle or opening will not be flooded in case a drain from the bowl of the fountain becomes clogged.
   c. The end of the nozzle should be protected by nonoxidizing guards to prevent the mouth and nose of persons using the fountain from coming into contact with the nozzle. Guards should be so designed that the possibility of transmission of infection by touching the guards is reduced to a minimum.
   d. The inclined jet of water issuing from the nozzle should not touch the guard, and thereby cause spattering.
   e. The bowl of the fountain should be so designed and proportioned as to be free from corners which would be difficult to clean or which would collect dirt.
   f. The bowl should be so proportioned as to prevent unnecessary splashing at a point where the jet falls into the bowl.
   g. The drain from the fountain should not have a direct physical connection with a waste pipe, unless the drain is trapped.
   h. The water supply pipe should be provided with an adjustable valve fitted with a loose key or an automatic valve permitting the regulation of the rate of flow of water to the fountain so that the valve manipulated by the users of the fountain will merely turn the water on or off.
   i. The height of the fountain at the drinking level should be such as to be most convenient to persons utilizing the fountain. The provision of several steplike elevations to the floor at fountains will permit children of various ages to utilize the fountain.
   j. The waste opening and pipe should be of sufficient size to carry off the water promptly. The opening should be provided with a strainer.
8. Household Filters - These are used where there is a deterioration in the quality of the delivered water. Unless rigid control is maintained over the cleaning and sterilizing of the filters, their use should be discouraged.
9. Improper Placing of Soil and Waste Pipes - Another source of contamination is through the improper location of soil and waste pipes with respect to water storage tanks and food handling and ice manufacturing equipment. Leakage is the chief source of hazard.
10. Open Top Water Containers - The use of open-top water supply and storage tanks is conducive to the entrance of dust and vermin with a resultant contamination of the water supply.

VACUUMS IN POTABLE WATER SUPPLIES

Recently many surveys, investigations and research have been carried on to determine the hazards of defective plumbing and interconnections. It has been found that the most important criterion used to determine what is and what is not defective plumbing is whether or not back-siphonage is possible. The criterion is very important because of the variability in the pressure in the potable water supply lines. It has been found that the pressure in these lines may be reduced to below atmospheric pressure from a few to many times a day. In 19[illegible] the National Association of Master Plumbers established a research program at the Institute of Hydraulic Research at the State University of Iowa on the problem of back-siphonage and the resultant pollution of water supplies. The conclusions of this investigation are given below:

1. Vacuum formations in water pipes cannot all be explained by analogy with the action of a simple siphon. Negative pressures in complicated piping systems due to a loss of pressure by friction may be very common.
2. Polluted water from a few submerged inlet fixtures in buildings can pollute the entire piping system in that building and the pollution may also get back into the street water mains.
3. Vacuums in pipe systems of buildings can be caused by negative water hammer pressure waves, local restrictions in pipes, and condensation of steam in hot-water tanks.
4. The air flow through any given size opening into the pipes in which a partial vacuum exists will reach a maximum value when the vacuum is 15 inches of mercury, and will not become greater with further increase in the degree of vacuum.

5. A separate water supply to submerged inlet fixtures in a building cannot be considered as a practical and adequate elimination of water pollution dangers because: First, the cross-connection hazard is enhanced due to the dual water supplies, one safe and the other unsafe; second, it cannot be used for submerged inlet fixtures requiring a pure water supply and also for various hot-water fixtures.
6. Installation of air inlets at tops of water risers and at various other points for purposes of vacuum prevention in water pipes is not the proper solution to the back-siphonage problem because: First, from a pneumatic standpoint entire prevention of partial vacuum formation by this means is practically impossible; second, air inlet devices installed under constant water pressures are entirely undependable.
7. The correct and only solution to the back-siphonage problem is elimination and correction of the individual unsafe fixture. The unsafe fixture is the fundamental evil in the plumbing system that makes back-siphonage possible, and therefore should be the point of attack.
8. Inlets should be raised above the top of the fixture a distance equal to the value from one of the two formulas, G = 2D or G = $2\frac{1}{4}$ times the square root of A, where G is the gap in inches, D the diameter of water inlet, and A is the minimum area of the inlet. This will prevent any siphonage from such a fixture and will provide a substantial factor of safety. For common types of fixtures, the following heights of gaps are recommended: Lavatory, 1 inch; kitchen sink and laundry trays, $1\frac{1}{2}$ inches; bathtub, 2 inches.
9. Under certain conditions, as specified in this report, overflows leading from the fixture to the atmosphere may be considered as determining the maximum possible water level of a fixture, and the water-supply inlet need only be raised above the overflow. However, raising inlets above overflows which connect to the atmosphere, either directly or through an air gap in the overflow pipe, cannot be considered as an ideal solution by any means.
10. The vacuum-breaking principle as defined herein has the necessary requisites for a proper solution to the back-siphonage problem. The proper application of this principle entails rigid requirements relating to the vacuum-breaking device used.
11. It is recommended that the vacuum-breaking principle be accepted as a tentative standard for the proper solution to the back-siphonage problem if the vacuum breakers used meet all requirements specified in this report. It is further suggested that such vacuum-breaking devices, installed on actual installations, be carefully observed for a number of years to note their performance characteristics before they are definitely accepted as standard.
12. The tank closet with the constantly submerged inlet presents as great a back-siphonage hazard as any fixture in the plumbing system. Every effort should be made by manufacturers of closet tanks to have the entire float valve and water-supply piping connections installed above the overflow level of the tank if the tank water is subject to sewage pollution. Unless especially well designed, it is not recommended that moving part vacuum-breaking devices be used in closet tanks because of the corrosive conditions.
13. Automatic flush valve fixtures should be protected from back-siphonage by incorporation of the following items: (a) A loose check valve to be incorporated in the stop valve; (b) Stable unit piston to be used if piston type valve is installed; (c) Vacuum breaker between the control valve and fixture which meets specified requirements for vacuum breakers; (d) No water supply connection to a closet bowl below the flush rim of the bowl should be permitted.
14. The frostproof closet presents such pronounced water-pollution hazards that its use even under the best conditions cannot be considered as satisfactory.
15. A great many hospital fixtures are excellent examples of the waterpollution hazards that can be introduced in the design of various special fixtures when important sanitary considerations are overlooked.
16. Manufacturers of special water-supply and plumbing equipment and fixtures should be ever alert regarding the introduction into the design of the fixture of back-siphonage hazards. Every attempt should be made to use the best solution to the back-siphonage problem; that is, "Inlet above top of fixture".
17. The best program to inaugurate for the elimination of direct cross-connection with auxiliary private water supplies is the eliminating of the wholesale presence of such supplies in buildings served with the public water supply. Only when such auxiliary supplies are reduced to a minimum can regulations and inspections be entirely effective.
18. Direct connection of city water to cooling and condensing systems used in gas compressors, refrigerating apparatus, and air-conditioning equipment should be condemned. Reuse of such water in the domestic supply systems of buildings is not satisfactory from a sanitary viewpoint.
19. Submerged inlet water-supply connections to water used for air washing, cooling, humidifying and dehumidifying should not be allowed.
20. In buildings, water that flows in a pipe of considerable length under gravity, should never be used again in the domestic supply system. The chances of the pipe being used for a waste connection are too great.
21. Tests indicate that the vacuum causing flow of air through rim ports of closet bowls and urinals, or through or over other surfaces likely to have polluted liquid drops adhering to them, should not be over 1 inch of water in order to prevent the picking up of polluted

liquid droplets and the carrying back of such pollution in the form of a spray into the water-supply pipes.

22. Most of the vacuums that occur in water pipes are caused by improper pipe sizing and by use of fittings and valves which introduce excessive friction loss. At least 90 percent of all vacuum formations could be prevented if water-piping systems were sized and installed correctly.

CORRECTIVE AND PREVENTIVE MEASURES FOR HOSPITALS, CAFETERIAS, LAUNDRIES, DORMITORIES, AND HOTELS.

Lavatory faucets should be provided with a gap of 3/4 inch between the lip of the faucet and the rim of the lavatory.
Bathtubs should be provided with the same gap between the faucet and the rim of the tub.
Closets should be of the tank type and the filling tube should be above the water line in the tank, that is, above the overflow point. Flushometer plus vacuum breaker is allowable.
Steam tables should be fed with water by means of an over-the-rim faucet. The drain for these should empty into an open pot trap.
Sinks should be provided with over-the-rim feed. Dishwashers should be supplied with water by means of a faucet that is higher than the overflow point -- about 3/4 inch.
There should be a distinct break in the water line before supplying potato peelers.
Water fed to condensers should, upon leaving the condenser, be emptied into an open pot trap.
A sitz bath should be fed, preferably, from a faucet over-the-rim of the tub above the overflow point of the bath. (If this is not possible a device may be arranged whereby the water empties into a standpipe a foot or so above the bath). This standpipe feeds the sitz bath below the rim and this same standpipe, being open at the top, provides a vent to eliminate all possibility of backsiphonage.
Continuous flow baths should be handled the same as sitz baths. Bidets should be fed from an open hopper. This hopper should be of a height to provide the proper water pressure.The break in the continuity in this case would be between the water line and the hopper.
Instrument and utensil sterilizers should be supplied with water by means of a swinging over-the-rim faucet. In this case, the faucet must be swung out of place before the cover of the sterilizer can be lowered. The waste line from the sterilizers should empty into an open pot trap. It is satisfactory to supply a water sterilizer direct but when the water leaves the sterilizer, it must be provided with a break in the continuity. The waste line should empty into an open pot trap before reaching the sewer.
All water suction devices or aspirators are a hazard and all new installations should provide suction by means of a vacuum pump. A vacuum pump and receiving tank should be located some place in the building and each room piped to this vacuum tank. When the suction is used, a receiver is installed in the room which collects any foreign matter in order to keep the suction system clean. This, of course, is ideal but proper use of a vacuum breaker is practicable.

PRINCIPLES GOVERNING THE INSTALLATION OF HOUSE PIPING.

Plumbing codes besides defining definite types and structures of equipment to be allowed, should also embrace a set of general principles as fundamental to the administration of the Code. They are:

1. Plans of proposed new installations or alterations of existing systems must be submitted to and approved by the Health Department or other proper constituted authority before starting work.
2. All inside piping must be installed under the supervision of a master plumber except in plants where competent pipers are regularly employed and except that connections to hot-water heaters and similar equipment may be made by persons regularly engaged in installing such equipment; all subject to inspection and approval by the Health Department.
3. All water supply installations should be tested under city pressure in the presence of a health department inspector before acceptance.
4. It should be required that the service be carried full size to the point where the last branch is taken off. Accessible separate shut-offs are required in the basement for each tenement and for each hot-water tank.
5. Concealed piping, tanks, etc., must be properly protected against freezing and must be tested before being concealed. The bottom of flush tanks for water closets or urinals must be above the overflow level of the fixture when the drain is obstructed.
6. When the water is delivered to any receptacle below the overflow line of the receptacle when the drain is plugged, it should be required that provision be made to prevent backflow from the receptacle, by siphon breaker, or other approved method.
7. Periodic inspection of plumbing should be required.
8. Educational facilities for education of technicians and the lay population should be provided.

SPECIFICATIONS FOR PIPES AND CONNECTIONS.
Water Supply - The water-service pipes of any building should be of sufficient size to permit

a continuous ample flow of water at any time. The flush pipe for water closets should be not less than $1\frac{1}{4}$ inches in diameter, and the water from flush tanks should be used for no other purpose.

Minimum Sizes of Water Supply Pipes

From curb to dwelling	3/4 inch
Sill cocks	3/4 inch
Hot water boilers	3/4 inch
Laundry trays	1/2 inch
Bath tubs	1/2 inch
Sinks	1/2 inch
Lavatories	3/8 inch
Water-closet tanks	3/8 inch

House Sewer and House Drain. The house sewer is made of cast iron or vitrified clay pipe. The required size of the house sewer will vary according to the number of fixtures drained by it. The house drain is of cast iron pipe of a size, depending like the house sewer on number of fixtures drained by it.

FITTINGS (3)

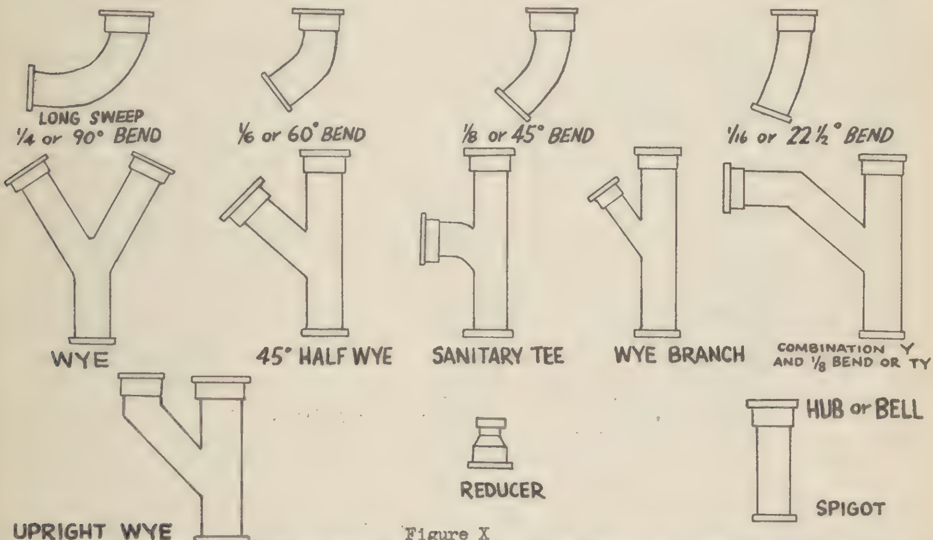


Figure X

In order to attain an adequate relation of the drainage needs of various types of fixtures, the following "fixture equivalents" have been adopted. (3)

1 Lavatory or wash basin	is	equivalent	to	1 fixture unit
1 Kitchen sink	"	"	"	$1\frac{1}{2}$ fixture units
1 Bathtub	"	"	"	2 fixture units
1 Laundry tray	"	"	"	3 fixture units
1 Combination fixture	"	"	"	3 fixture units
1 Urinal	"	"	"	3 fixture units
1 Shower bath	"	"	"	3 fixture units
1 Floor drain	"	"	"	3 fixture units
1 Slop sink	"	"	"	4 fixture units
1 Water closet	"	"	"	6 fixture units

SIZES OF HOUSE SEWERS AND DRAINS (3)

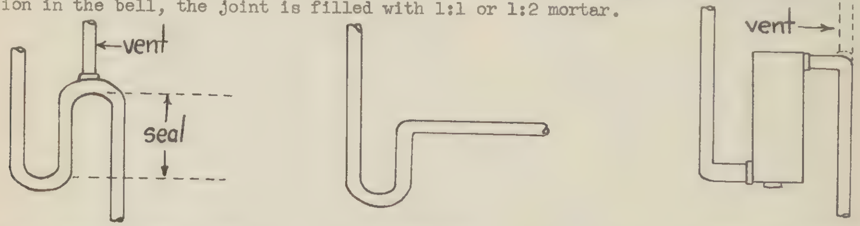
Number of fixture units	Slope 1/8 inch to 1 ft.	1/4 inch to 1 ft.	1/2 inch to 1 ft.	Number of water Closets or Equiv.
6 to 12	4 inches	*3 inches	*3 inches	1 to 2
13 to 24	4 "	4 "	*3 "	3 to 4
25 to 72	6 "	5 "	4 "	5 to 12
73 to 300	8 "	6 "	5 "	13 to 50
301 to 720	8 "	8 "	6 "	51 to 120
721 to 1,080	10 "	10 "	8 "	121 to 180
1,081 to 1,920	12 "	12 "	10 "	181 to 320

* No horizontal sewer or drain receiving water closet should be less than 4 inches.

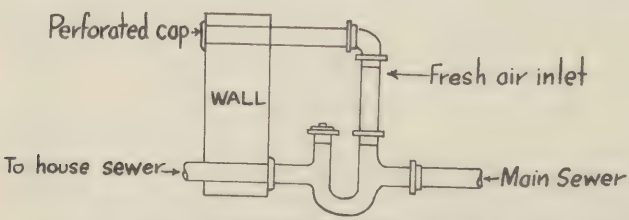
The Main Trap - This trap, if used, is placed in the house drain just within the foundation walls. It is a running trap and should have at least one clean-out hole. The purpose of the trap is to isolate the house-drainage system from the sewer, particularly to prevent passage of sewer air into the house system. If it is used, a fresh air inlet is necessary, running from the house side of the main trap to the outer air. The fresh air inlet allows circulation of air through the house drain into the stacks and vent pipes.

Changes in Direction. Changes in direction of pipes are made by the use of 45° wyes, half wyes, long-sweep quarter bends, sixth, eight, or sixteenth bends. Sanitary tees may be used on vertical stacks and short quarter bends may be used in soil and waste lines when the change in direction of flow is from horizontal to the vertical. Tees, crosses, and short quarter bends may be used in the vent pipes.

Joints. - Joints in cast-iron soil pipe known as caulked joints are made by firmly packing the opening between the bell and spigot with oakum or hemp and then pouring in pure hot lead to a depth of not less than 1 inch. The lead is then tamped or caulked so that the joint will be tight. No paint, varnish, or putty is permitted until after the joint is tested. In joining wrought iron, steel, or brass to cast iron, either screwed or caulked joints are used. When joining lead pipe to cast iron, steel or wrought iron, the joint should be made by means of a ferrule, soldered nipple, or bushing. Joints in lead pipe or between lead and ferrules, or with brass or copper pipe, should be wiped joints, with an exposed surface of the solder to each side of the joint of not less than 3/4 inch and the minimum thickness at the thickest part of the joint of not less than 3/8 inch. Joints in vitrified tile pipe are usually made with cement. A gasket of jute or oakum is soaked in cement grout and placed around the end of the spigot of the pipe to be laid. After the spigot has been placed in position in the bell, the joint is filled with 1:1 or 1:2 mortar.



S TRAP WITH CROWN VENT   P TRAP   DRUM TRAP



Main Trap with Fresh Air Inlet (3)   Figure XI

Drum traps are somewhat more resistant to siphonage than S or P traps but do not give so good a scouring velocity. They must have vents.

Venting Systems - No vents are less than $1\frac{1}{4}$ inches in diameter. For $1\frac{1}{4}$ and $1\frac{1}{2}$ inch wastes the vents are the same diameters as the waste pipes. Branch vents or main vents should never be less than half the diameter of the soil or waste pipe they are venting. The size of main vents and vent stacks is based upon the size of the waste or soil stack, the number of fixtures or closets connected and the actual length of the vent or vent stack.

Sizes of Vents Required on Waste Stacks (3)

Diameter of Stack, inches	Fixture units on Stack	Dimensions of Vent	
		Diameter, inches	Maximum Length, feet
$1\frac{1}{4}$	1	$1\frac{1}{4}$	45
$1\frac{1}{2}$	2 to 8	$1\frac{1}{4}$	35
$1\frac{1}{2}$	2 to 8	$1\frac{1}{2}$	50
2	9 to 18	$1\frac{1}{4}$	30
2	9 to 18	$1\frac{1}{2}$	60
2	9 to 18	2	75
$2\frac{1}{2}$	19 to 36	$1\frac{1}{4}$	25
$2\frac{1}{2}$	19 to 36	$1\frac{1}{2}$	45
$2\frac{1}{2}$	19 to 36	2	60
$2\frac{1}{2}$	19 to 36	$2\frac{1}{2}$	105

Stacks - At least one of the stacks of the plumbing system must extend full size through the roof for the following purposes: (a) Ventilation and carrying of the sewer air above the roof, (b) Prevent siphoning of the traps by suction, (c) Prevent possibility of a back pressure forcing the seals of the fixture traps.

Size of Waste Stacks (3)

No. of Fixture Units	Diameter of Stack	Maximum permitted length
1	$1\frac{1}{4}$ inches	45 feet
2 to 8	$1\frac{1}{2}$ inches	60 feet
9 to 18	2 inches	75 feet
13 to 36	$2\frac{1}{2}$ inches	105 feet

Size of Soil and Waste Stacks (3)

No. of Fixture Units	No. of Water Closets or Equivalent	Diameter of Stack	Maximum permitted Length
37 to 72	1 to 12	3 inches	150 feet
73 to 300	13 to 50	4 inches	225 feet
301 to 720	51 to 120	5 inches	300 feet
721 to 1,080	121 to 180	6 inches	400 feet
1,080 to 1,920	181 to 320	8 inches	600 feet

Pipe Supports - Since cast iron stacks and soil pipes are jointed with lead it is important that they be properly supported, otherwise changes in alignment may occur that will cause leaks. Vertical stacks should be supported at their bases by brick or concrete piers and at each floor a wrought-iron strap should be placed just below the bell of the joint or branch of a fitting securely fastening the pipe to a rafter or vertical timber. Each joint of a horizontal line should be supported in some way; if over head, by straps, if close to the floor or ground, by piers or special supporting fittings.
Fixture Traps and Trap Venting - The pipes which carry off the waste from various plumbing fixtures would allow the entrance of air from the plumbing system into rooms if traps were not placed in the waste-pipe lines. The trap seal should be not less then 2 inches or more than 4 inches. S traps must be crown vented to prevent siphonage, but this type trap should be discouraged. P traps may be used safely without venting if they are within 5 feet of a waste stack into which the waste pipe discharges and if the horizontal waste pipe does not join the stack at a point lower than the dip of the trap.

Sizes of vents required on soil and waste stacks may be secured from any master plumber.

1. Continuous Venting - This sytem is adopted in houses of two or more floors. It should be noted that the vent stack should connect with the main stack at the bottom at an acute angle.

2. Loop Venting. This used in the case of a closet which is too far from the waste stack to be vented by it.

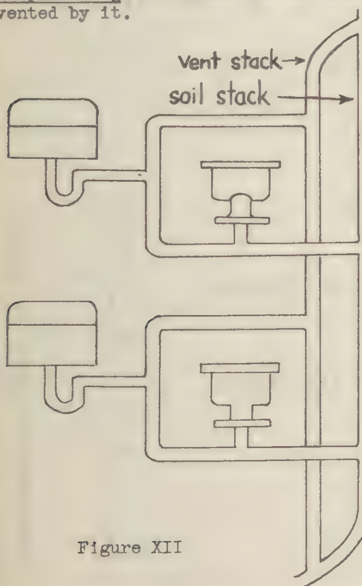


Figure XII

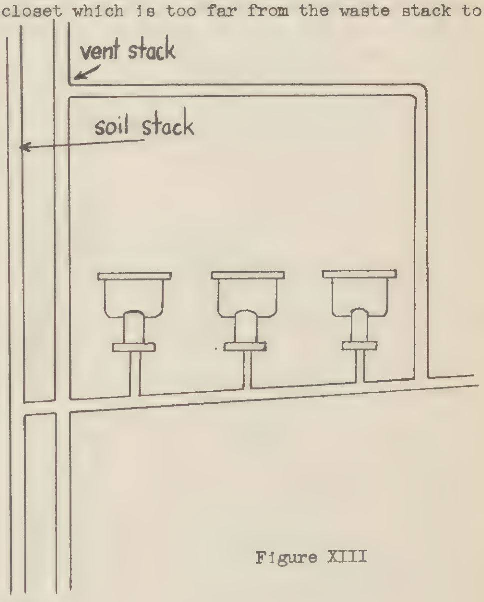


Figure XIII

3. Circuit Venting. This is used in instances similar to that of loop venting.(Figure XIV)

4. Crown Venting. This vent runs from the crown of the individual trap to the vent stack. (Figure XV)

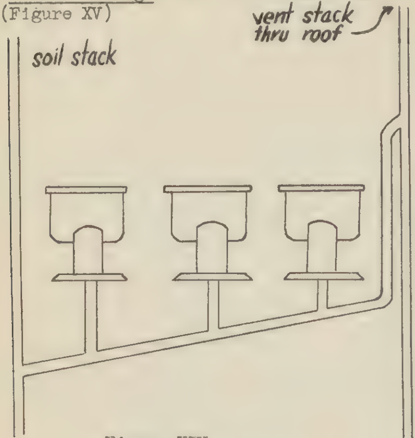


Figure XIV

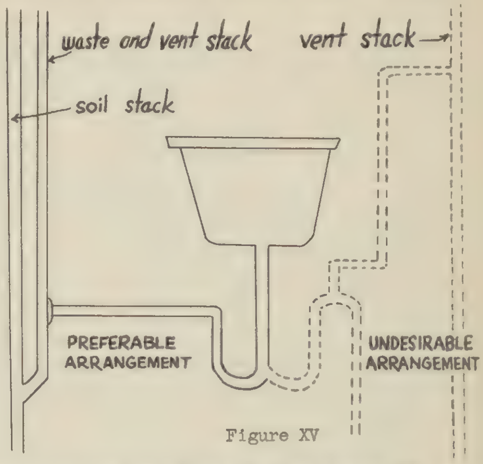


Figure XV

5. Local Venting. This method of venting is not connected with the plumbing system. The vent pipes are so placed as to carry away foul odors from the vicinity of plumbing fixtures. Local vents are sometimes attached to closet bowls and the outlets in some instances are in the chimney. Horizontal Piping. All horizontal piping should run at not less than a uniform grade of 1/8 inch per foot and should be supported or anchored. Dead ends are prohibited. Grease Traps. These are installed for the purpose of removing grease from waste water. They should be placed as near as possible to the fixture they are serving, and should be frequently cleaned. The best grease trap has a cold water supply for the purpose of chilling the waste water as it enters the traps, thereby causing stiffening of the grease and its retention in the trap. Fixtures . Fixtures should be of modern and approved types and material. Closets should be molded in one piece, should hold sufficient water between flushes so that surfaces should not be fouled, and should have a flushing rim that will insure complete cleansing of the inside of the bowl. All fixtures should be installed to allow ease of cleaning. Built in and encased plumbing should not be approved. The overflows from wash bowls, bathtubs, etc. should enter waste pipes on the inlet side of the trap. Good practice requires that all fixutre pipes run directly into the wall and that no lead pipes or traps be within 12 inches of the floor unless protected. Strong metal strainers are required at the outlets of all fixtures except closets and pedestal urinals. Fixture Wastes . Requirements as to waste - pipe sizes vary somewhat in plumbing codes. For instance, the minimum size pipe for one kitchen sink may be 2 inches in one code and $1\frac{1}{2}$ inches in another. Closet Floor Connections. This connection at the floor between a closet and the soil pipe is frequently made in an unsatisfactory manner and should be carefully inspected. An example of a good connection is shown in Figure XVII.

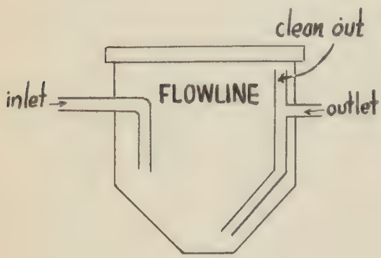


Figure XVI

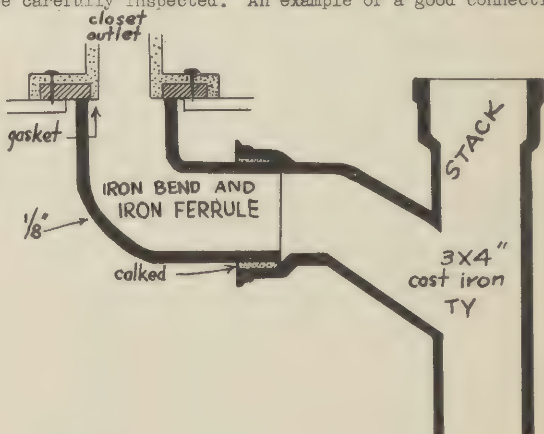


Figure XVII

Inspection. The first inspection is made after the "roughing in", i.e., when all the work has been done up to the setting of the fixtures and with all the piping open to view. Usually at this time the water test is given. All of the openings except the top of the stack are closed by caps, soldering, or special plugs, and the complete system is filled until water flows from the top of the stack. The water is then allowed to stand in the pipes for a period of at least 15 minutes. Every part of the system should be tested with at least a 10 foot head of water. All joints should then be examined for leakage. In case of a very high building, it may be necessary to test the system in 75 foot sections of stack. The best final test is by the use of air, although this may also be used for preliminary testing. If used for preliminary test, a pressure of 10 pounds per square inch is applied. The final test is made after the work is completed and after the traps have been filled to obtain their seals. In this case the air pressure applied is equal to 1 inch of water column for a period of 15 minutes. This will indicate whether the trap seals are sufficient. When the preliminary air test is used the joints are examined by the application of soap suds with a brush.

The smoke test has also been used. In this case a special smoke-producing machine is required and after the system is filled with smoke, air pressure equal to 1 inch of water column is applied.

It is possible to make simple tests for the purpose of discovering whether traps are sealed or not. If knocking in the pipe at the trap results in a hollow sound, it will probably mean that the trap seal has been lost. A still better method is to hold a match at the entrance to the waste pipe. Flickering will indicate a loss of the trap seal.

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1. Plumbing and Public Health - Public Health Bulletin
2. Plumbing in Relation to Public Health - Minnesota State Board of Health
3. Municipal and Rural Sanitation - Ehlers and Steel
4. Louisiana Sanitary Code
5. Preventive Medicine and Hygiene - Rosenau

OUTLINE OF FOOD HANDLING SANITATION
(See next Section)

A. Safe Handling
   1. Safe production and preservation
   2. Safe distribution and consumption

B. Protection Against Misrepresentation
   1. Definition of terms
   2. Definition of standards
      a. Adulteration
      b. Misbranding
   3. Penalties for violations

C. Administration for Epidemiological Control
   1. Registration of producers and collection of fees
   2. Identification and dating of foods

D. Legal Powers Provided for Enforcement of Measures for:
   1. Safe handling
      a. Power of entry
      b. Right of sampling
      c. Right of seizure of unsound foods
      d. Right of destroying unsound foods
      e. Right to demand injunction proceedings
      f. Right to demand medical examination of food handlers
      g. Right to demand safe techniques and procedures
   2. Protection against misrepresentation
   3. Administration of epidemiological control.

Food Handling Sanitation

The recognition that mishandled food may produce sickness and death goes back to the earliest period of recorded history. But the theories evolved up to Pasteur's time as to the cause of bad or spoiled food were fanciful and inaccurate. In spite of the falsity of the theories, practical results were attained with some degree of success. Thus, the Mosaic law forbade the use of pork which today is recognized as the chief means of spread of trichinosis. Shellfish was forbidden which today is recognized as a source of typhoid fever and dysentery. The combination of meat and milk was prohibited from use. Today it is known that these two are excellent mediums for bacterial growth. In the 14th Century in France, butchers were forbidden by law to sell meat more than two days old in winter or one and one-half days old in summer, and fish had to be sold on the same day when caught. The development of bacteriology and chemistry has directed knowledge of spoiled food into more and more accurate conceptions. Today enough is understood about this subject to carry on a successful campaign against sickness caused by spoilage in one way or another.

The fundamental causes of food spoilage are few, but the innumerable circumstances in which these causes may act necessitate the strickest vigilance in the handling of food. For example, one fundamental cause is bacterial infection of food, but such infection may take place in any number of circumstances associated with the handling of food in the process of production, preservation, distribution, and consumption.

The primary causes of food spoilage are: (1) bacterial infection (2) chemical deterioration (3) adulteration with poisons.

Any of these causes may operate in any of the processes of handling food. Thus, safe food handling consists in: (1) sanitary production and preservation (2) sanitary distribution and consumption.

SANITARY PRODUCTION AND PRESERVATION

Since every step in the handling of food may be a circumstance during which spoilage may occur, the sanitarian must train himself to visualize every minute movement of the handlers of food, the design and mechanism of every tool and machine associated with the handling, the techniques and processes carried on, and the nature of the food itself. Besides this, the sanitarian should know where the raw food itself came from, the sanitary history of the locality, the sanitary history of the place where the production and preservation is carried on, and the health status of the food handlers and their families so far as communicable diseases are concerned. For example, in the production and bottling of milk, he should know: whether diseases such as typhoid fever, tuberculosis, Bang disease, scarlet fever, and the like are prevalent in the locality; whether any communicable disease capable of spread by milk exists among the milk handlers or their families; whether carriers of such diseases exist; the sources of water supply and methods of feces and other wastes disposal; the sanitary conditions of the buildings where milk is being produced; the technique of milking, cooling, pasteurizing and bottling; whether breaks in the approved technique occur due to poor tools, machines or inefficiency of the workmen; whether the cream is being separated or any material being added; whether the milk is of good quality before processing; whether preservative is being added or adulteration practiced.

Many other questions could be entertained about production and preservation of milk and other foods. In the case of fresh vegetables or fruits, one should not forget to inquire whether the land where they are grown is fertilized with human excreta or whether insecticides poisnous to man are used to control insect pests. In case of meats, one should not forget to examine for preservatives, and attempt to become acquainted with the slaughter houses if they are locally situated. The diseases in animals for which meats are condemned are tuberculosis, trichinosis, anthrax, hog cholera, lumpy jaw (actinomycosis), tapeworm cysts, acute inflamations, chemical poisons, and many others.

It cannot be too strongly emphasized that in the vast majority of outbreaks of food infections, the food affected is not noticeably altered in appearance, taste, or smell, yet the sanitarian must know the appearance, taste and odor of tainted food.

FOOD POISONING

This term is used to designate a disease causing acute attacks of illness due to some injurious property in food. This is a better term than "ptomaine poisoning", which is unscientific and incorrect. There are 5 recognized types of food poisoning, 3 associated with

bacteria and 2 with chemical poisons. They are: (1) botulism, (2) staphylococcus toxemia, ( ) infections, (4) organic chemicals, (5) inorganic chemicals.

Botulism is due to contamination of food by the specific bacterium know as Bacillus botulinus or Clostridium botulinum. This germ is found in the soil practically throughout the world. When so-called non-acid or slightly acid foods such as many vegetables, fish and meat, are preserved by faulty and unsanitary methods, this bacterium may be present and find a good medium in which to grow. While growing in such a medium under anaerobic conditions, it produces a poison which, when consumed, produces a reaction in the body which may cause mortalities ranging from small percents to as high as 100 percent. The poison of this disease attacks the nervous system and therefore it is called a neurotoxin.

There are at least 3 types of botulinus bacteria, designated A,B, and C. Type A usually produces the most concentrated toxin. This is sometimes so powerful that one part in 10,000,000 will injure a mouse. The amount of toxin produced depends on the nature of the food, on the pH, on the amount of sugar present, and on other factors modifying the medium. In the United States, foods which serve as the most dangerous media for toxin production are string beans, corn, spinach, olives, asparagus, beets, and apricots. In Europe, most of the trouble has been due to toxin formation in sausages, meat and fish pastes. In the United States, most of the outbreaks now follow the eating of home-preserved vegetables or fruits served cold as salads. Years ago commercially canned foods were often at fault, but after intense research, methods were developed for destroying the highly heat resistant spores that caused the trouble. Since then, it has been mostly the home-preserved foods that have caused outbreaks of botulism. The great difficulty with home canning comes in sterilizing the containers and the food without the use of steam under pressure. Some spores can survive boiling for 6 hours, or subjection to steam under 15 pounds pressure for 6 minutes. Although short periods of boiling may not destroy the spores, 6 minutes of boiling will destroy the toxin, therefore all home-preserved foods should be boiled 6 minutes before they are tasted or served. Preserving foods in at least 10% brine solution will make home canned foods reasonably safe. The symptoms of botulism begin as early as 24 hours after consuming the poisoned food.

Staphylococcus toxemia or staphylococcus food poisoning is caused by eating foods which have been contaminated by staphylococcus bacteria, through the agency of a human or animal carrier. The specific bacterium almost always causing this type of food poisoning is staphylococcus aureus. A survey of the epidemics which have occurred from this organism indicate that certain types of bakery products, particulary those containing a cream or custard filling, have most frequently been involved, although various other food products such as milk, gravy, cheese and meat have been occasionally incriminated. From all indications, those meats which have been salt-cured and are of the "ready to eat" types, like ham, are beginning to loom as important as bakery products causing staphylococcus food poisoning. After foods have been contaminated through improper handling and are subsequently incubated after insufficient cooking, refrigeration, or storage, the bacteria grow and secrete a toxin, or double toxin, part of which is destroyed by heating and part of which will not be destroyed at 100°C. Salads or sandwiches prepared to be used the following day at picnics or dinners should be discouraged, since if contaminated, it gives adequate time for production of toxin. This type of food poisoning can be prevented through the continued use of relatively simple methods of cleanliness, proper manufacturing and merchandising, and protection against contamination and incubation of the product, particularly through sterilization of equipment and thorough adequate refrigeration. The symptoms from this poisoning develop several hours to a day after consumption of the contaminated food. There is appearing evidence that other bacteria such as streptococci, coli, and proteus may produce this type of food poisoning. The mortality rate is very low although the body reaction may be very severe and last several days. It is important that food handlers with boils or festering sores on hands should not be allowed to handle food.

The food poisonings caused by infections are due to the Salmonella group of bacteria. In this group belong the various bacteria that produce paratyphoid fever and which are transmitted from man to man. In this group also belong various bacteria of animal sources that produce food poisoning which resembles an infection and simulates the picture of dysentery. The latter is mainly caused by three types from the Salmonella group, Bacterium typhi-murium (or aertrycke), Bacterium enteritidis (or Gaether's bacillus), and Bacterium newport. The animals which are the main sources of this type of food poisoning are rats, mice and fowl. Animals like cattle or hogs which are infected by this group of organisms may produce food poisoning when used for human consumption. Meat from healthy animals may become infected after slaughter. The symptoms of this disease occur quickly after ingestion of the food, but the periods tend to be somewhat longer than that produced by staphylococcus poisoning. This type of food poisoning may be prevented by proper handling of food, restriction of use of meat from animals which are infected by any of the Salmonella group, and rat control.

Here it is important to distinguish between beneficial bacterial action on foods and dangerous bacterial action on foods. Decomposition is usually the result of bacterial action,

but it may take place also as a result of physical, chemical or electrical agencies. Some types of decomposition are objectionable as for example an old egg, but in some instances decomposition renders food more tender and improves the flavor. Some people prefer highly decomposed or gamey meat. Bread, cheese, buttermilk, sauerkraut, vinegar, cider and many other foods are decomposition products of yeast fermentation or bacterial action or a combination of both to produce definite changes in the particular food. The health worker's principle concern is decomposition that may be harmful to health. Decomposition that takes place in the presence of bacteria which elaborate toxins is to be avoided, not because of the decomposition but because of the toxin. Ptomaines are intermediate cleavage products of protein decomposition. Some ptomaines are supposed to be toxic but most are not.There is the belief that there really is no such condition as ptomaine poisoning.

Poisoning by organic chemicals is infrequent. The most common poisoning of this type is from poisonous mushrooms. Recently cases of mussel poisoning have been reported. There is, of course, possibility of poisoning from the ingestion of any type of poisonous vegetation. This type of poisoning is certainly a public health problem but is of minor importance compared with bacterial food poisoning.

Food poisoning by inorganic chemicals is of great import in public health especially because the poisons gain access to the food usually by methods which violate the laws of our country and because the types of foods which become so poisoned are common foods consumed by large sections of our population. Adulteration of food consists of a large number of practices, some of which are fraudulent and others technical in nature. Some forms of adulteration are injurious to health, but for the most part they have an economic rather than a sanitary significance. Foods may be adulterated by removal of nutritive substances, by addition of injurious substances, by fraudulent substitution of cheaper articles, by misbranding, or by the sale of food that is filthy, decomposed or putrid. See definition of adulteration according to Louisiana Act - 142 - 1936 in following pages.

Prior to the passage of the federal pure food and drugs Act in 1906, a large percentage of the food sold in the United States was found to be adulterated in one way or another.

Effective food control has developed principally as a result of three factors. The first factor was the gradual change of the manufacture of food from home to factory. The second factor in making more effective food control was the development of bacteriology and chemistry. The third factor was the educational work carried on by the American Public Health Association and similar agencies. As a result of the operation of these three factors during the first decade of the existence of the American Public Health Association, the states began to consider and, in a few instances, to enact legislation for control of traffic in food. New York in 1881 enacted the first state food control laws. In the same year Michigan, New Jersey and Illinois followed New York's example. In 1883 Maine, Nebraska and Ohio came in; in 1885, Massachusetts and Pennsylvania; in 1887, Virginia; in 1888, Iowa and Vermont; in 1889, Connecticut, Kansas, and Wisconsin. From 1890 to 1895 laws of general or specific nature were passed in Maryland, New Hampshire, New York, Colorado, California, Georgia, Indiana, North Carolina, North Dakota and Washington. During the decade following 1895 the state legislatures were active in amending old and in passing new food laws.

The economic features of food adulteration were early recognized and published in the "Transactions of the Medical Society of the State of New York". In 1879 there was a paper stating that "A very large proportion of the adulterations practiced are not attempts at fraud, nor designed to damage health, but are strained efforts to make money. And these efforts are so earnest and so intense, energetic and absorbing as to leave all other considerations in the background".

All federal food-control legislation is based upon the taxing power of the federal government, or its power to regulate foreign commerce, or its power to regulate commerce between various states. A federal law was passed in 1886 placing a tax upon oleomargarine and regulating its sale. This was amended in 1902. In 1896 the law regulating the taxing of filled cheese was enacted, and in 1898 a mixed-flour law was passed. The application of that clause of the Constitution which gives the federal government power to regulate foreign commerce was invoked as early as 1848 for the control of imported drugs. In 1890 a very general law was passed relating to exported and imported foods, but no special provision was made for its enforcement. In 1897 a law relating to the importation of tea was passed and an effective control established. In 1900, the Bureau of Chemistry of the Department of Agriculture was given authority to examine imported shipments of food and to exclude from the country such shipments offered for entry as were adulterated or misbranded. A meat inspection law was passed in 1891, but this law was not very effective and meat inspection did not become so until 1906 when the Federal Food and Drugs Act was passed and became effective January 1, 1907. This act served splendidly in spite of the many controversies which grew around it. But our country continued to grow, and with it grew the techniques of food production and preservation, and also drug and cosmetic manufacture. Needs for changes in the Federal Law

became apparent some years ago. The State of Louisiana seeing that the forces demanding change were swiftly accumulating, seized the opportunity to formulate a Pure Food, Drugs and Cosmetics Acts based on the provisions of the newly proposed Federal Act, and passed the law in 1936 becoming the first state in the Union to adopt a law so comprehensive for present needs. The State of Louisiana passed its present law two years before the federal government itself finally approved its present law in 1938. The one important difference between the Federal and State Acts is that the State Act provides for registration by all food,drugs and cosmetics manufacturers, packers or distributors of processed foods, patent or proprietary drugs, prophylactic devices and cosmetics before they are distributed for sale, thus, to a great extent preventing adulterated, decomposed or misrepresented foods, drugs and cosmetics from reaching the market. This provision is not contained in the Federal Food and Drugs Act of 1938. In 1942 the regular session of the Legislature amended Act 142 of 1936.

The quantity and quality of foods are established by the standards and definitions adopted by the federal government and embodied in the two terms "adulteration" and "misbranding". A food is considered adulterated as defined in the Federal Food, Drugs and Cosmetic Act of 1938:

1. Mixing - "If any substance has been added thereto or mixed or packed therewith so as to increase its bulk or weight, or reduce its quality or strength, or make it appear better or of greater value than it is";or "if it is confectionery, and it bears or contains any alchohold or non-nutritive article or substance except harmless coloring, harmless flavoring, harmless resinous glaze in excess of four-tenths of 1 percent natural gum and pectin". Examples - adding talc to flour, glucose and carmel to maple syrup, water to butter.

2. Substitution - "If any substance has been substituted wholly or in part therefor".Examples-substituting cottonseed or cornoil for olive oil, glucose or saccharin for sugar, cereals in sausage.

3. Abstraction of valuable constituents - "If any valuable constitutent has been in whole or in part omitted or abstracted therefrom". Example - Skimming milk.

4. Concealing Inferiority - "If damage or inferiority has been concealed in any manner" or "If it bears or contains a coal-tar color other than one from a batch that has been certified in accordance with regulations as provided by" this Act.

Substances used to color foods are usually considered in four classes: mineral dyes,vegetable dyes, aniline or coal-tar dyes, and ethylene for ripening and coloring. The principle mineral dyes are: copper sulphate, used to give a bright green color to peas, pickles and similar foods; iron oxide or sulphites, used to redden meat; potassium nitrite, used to give bright red color to pickled or corned meats. Many vegetable dyes are used such as annatto or carrot juice in coloring butter, tumeric in mustard, logwood in wines. The coal-tar dyes have largely replaced the vegetable and mineral pigments in foods on account of their brilliant color and cheapness. They are used in sausage, confectionery, jellies, hams, meats, flavoring extracts, etc. The permitted dyes are harmless to health. Ethylene is used to artificially ripen and color citrus and other fruits, tomatoes, etc.

The artificial coloring of food is a false standard and serves no useful purpose. When used to conceal damage or inferiority the practice is undefensible and an adulteration. Flour bleached with nitrogen peroxide is poisonous. Bleaching flour with oxide or nitrogen,nitrous oxide, nitrates, or chlorine is not dangerous but is deceptive. Dried fruits bleached with sulphur fumes leaves objectionable sulphur compounds. Candies are sometimes coated with gum benzoin or shellac.

5. Injurious substances - "If it bears or contains any poisonous or deleterious substance which may render it injurious to health", or "if it bears or contains any added poisonous or added deleterious substance which is unsafe" or "if its container if composed, in whole or in part, of any poisonous or deleterious substance which may render the contents injurious to health". Examples - Adulterants such as formaldehyde, sulphites, arsenic, hydrofluoric acid, lead, salicylic acid, borax, boracic acid, etc.

6. Decomposition and contamination - "If it consists in whole or in part of any filthy,putrid or decomposed substance, or if it is otherwise unfit for food", or, "if it has been prepared, packed, or held under insanitary conditions whereby it may have become contaminated with filth, or whereby it may have been rendered injurious to health", or "if it is, in whole or in part, the product of a diseased animal or of an animal which has died otherwise than by slaughter". Examples - Oysters contaminated with sewage, eggs known as 'rots and spots', beef from tuberculous cattle, figs containing excessive quantity of worms or worm excrement.

7. Misbranding - This term is specifically defined in the Federal Food, Drugs and Cosmetic Act of 1938, and provides for all possible conditions of fraud, mislabeling, imitation, and misrepresentation. It defines positively the manner in which foods should be labelled in order that the purchaser may under ordinary conditions be aware of what is contained in the food or if any artificial flavoring, coloring, preservative has been added, or the food specially processed. The container must in no way be misleading and the name, address of manufacturer, packer, or distributor must be on the label, also the quantity of food in weight, measure or numerical count. In the above sense misbranding may be regarded as a special form of adulteration.

The Food, Drugs and Cosmetic Act of the State of Louisiana of 1936 provides similar standards,

definitions and provisions for protection against adulteration and misbranding as does the Federal Act. Adulteration in accordance with the Louisiana Act - 142 is defined as follows-

ADULTERATED FOOD

Section 3. A food shall be deemed to be adulterated if it has been found to be such by any department of the United States Government, or:
(a)(1) If it bears or contains any poisonous or deleterious substances which may render it dangerous to health; or (2) if it bears or contains any added poisonous or added deleterious substance which may render it injurious to health, or which is prohibited by Section 6, or in excess of the limits of tolerance prescribed by regulations as provided by Sections 6 and 15; or (3) if it consists in whole or in part of any filthy, putrid, or decomposed substance, or if it is otherwise unfit for food; or (4) if it has been prepared,packed, or held under insanitary conditions whereby it may have become contaminated with filth, or whereby it may have been rendered injurious to health; or (5) if it is the product of a diseased animal or of an animal which has died otherwise than by slaughter; or (6) if its container is composed of any poisonous or deleterious substance which may render the contents injurious to health.

(b)(1) If any valuable constituent has been in whole or in part abstracted therefrom; or (2) if any substance has been substituted wholly or in part therefor; or (3) if damage or inferiority has been concealed in any manner; or (4) if any substance has been added thereto or mixed or packed therewith so as to increase its bulk or weight, or reduce its quality or strength, or create a deceptive appearance.

(c) If it contains a coal-tar color other than one from a batch that has been certified in accordance with regulations. Such certificate shall contain the physiological factor or factors and give notice that only such factor or factors have been tested. No persons, firm or corporation shall use such certificate in the label or advertising of any food.

(d) If it is confectionery or ice cream, it shall also be deemed to be adulterated if it bears or contains any alcohol, resinous glaze, or nonnutritive substance except harmless coloring, harmless flavoring, natural gum, and pectin: Provided, that this paragraph shall not apply to any confectionery or ice cream by reason of its containing less than one-half of 1 per centum by volume of alcohol derived solely from the use of flavoring extracts, or to any chewing gum by reason of its containing harmless nonnutritive masticatory substance.

PRESERVATION OF FOODS

The preservation of meat, milk, vegetables, and other perishable foods is one of the important questions we have to deal with in public health. The proper preservation of food stuffs involves not only the art of keeping them "fresh" and wholesome, but also keeping them so that they will not lose their nutritive value, or will not acquire injurious properties. The preservatives ordinarily in use are: Cold, drying, salting, smoking, canning, preserving, chemical treatment, fermentation, and physical processes. Practically all of these methods have long been in use. The only modern innovation in the preservation of foods is in the perfection of the old processes, and the use of mechanical means, such as vacuum, filtration, pressure, radiation, and quick freezing. The art of preserving foods successfully is largely a problem in applied bacteriology. The chief mischief was the threat of a blind use of chemical germicide without regard for their effect upon health. The National Pure Food and Drugs Act of 1906 was passed largely to meet this situation.

Refrigeration - Cold prevents bacteria from growing and prevents the action of enzymes which cause ripening. It does not kill bacteria. Some animal parasites die in cold storage. Thus, trichinae die at or below 5° F in less than 20 days. Taenia Saginata (beef tapeworm) die within 6 days at 15°F. The best temperature at which food stuffs may be kept must be determined in each case. Some substances, such as meat, fish and poultry, are better preserved when actually frozen, other, such as shell-eggs, milk, potatoes, oranges, and others are materially injured by freezing. Frozen food should be consumed within a few hours after defrosting or, if cooked, the cooking should be begun on the frozen fruit or vegetable. Meat or fish will have a better texture if cooking is begun before defrosting has been completely accomplished. The temperature of household ice boxes should not rise above 7°C or 45°F. Cold storage temperatures must be below freezing. From the sanitary standpoint, refrigeration is one of the best methods of preserving foodstuffs. It neither detracts from or adds to the taste, nutrition, digestibility, and at the same time prevents decomposition and bacterial growth.

Drying- Dryness furnishes excellent antiseptic conditions since bacteria need moisture to grow. It increases the keeping quality of food and reduces the weight and bulk. Drying has little effect on vitamins except on Vitamin A and C. If dried correctly, meats may last indefinitely. Drying fruits is sometimes accomplished by exposure to sulphur fumes. This

process is objected to from the standpoint of health for the reason that the sulphurous acids and sulphates are admittedly injurious. Dried milk seems to retain all its essential qualities except vitamin C. If kept too long it will turn rancid. Dried eggs in form of egg powder keep well and retain practically all the nutritive value of the original egg.

Salting and Pickling - The preservation of meat with brine or common salt is one of the oldest processes known. The brine should contain from 18 to 25% salt. For red meats a little potassium nitrate or nitrate is often added because of its slight antiseptic properties and its ability to bring out the red color in the meat. The nutritive value and digestibility of salted meat is somewhat reduced. Botulinus bacteria will grow better in low salt concentrations than high. Salted and pickled meats must always be watched for this possibility. The preserving action of salt depends largely upon dehydration, but also upon direct effect of the chlorine ion, removal of oxygen, and on interference with rapid action of proteolytic enzymes. Pickling includes preservation of food in brine, vinegar, weak acids and the like. These substances have bacteriostatic and also feeble germicidal properties, depending upon their concentration. Pickled meats are prepared by soaking meat, especially pork, in a brine made of common salt, though other substances, such as sugar, vinegar and spices are often added. Sulphate of soda, boric acid, borax and benzoic acid and other chemical preservatives formerly used are no longer permitted by the U. S. Bureau of Animal Industry. With proper methods chemical antiseptics are not necessary. Trichinae die after prolonged period of pickling. Tape worm larvae encysted in meat die materially in 21 days following death of host, but brine promptly kills these larvae.

Preserving - By preserving is commonly understood the addition of a large amount of sugar. The principle preserves are jellies, marmalades, jams and fruit butters. The cooking process which this involves usually protects against infection. Strong solutions of sugar prevents growth of bacteria, but does not kill bacteria. However, most pathogens die under such conditions in the course of time. A strong syrup (50% sugar) is necessary to prevent the growth and development of botulinus toxin. Jellies are frequently adulterated by the substitution of apple stock. Apples contain a carbohydrate called pectose which aids jellification. Jellies are also colored artifically, particularly with coal-tar dyes. Artificial flavors are sometimes employed. The chemical preservatives most frequently added to jellies and preserved fruits are benzoic acid and benzoate of soda. Salicylic acid and others are prohibited.

Smoking - The smoking of fish, beef, pork, and other meat food products consists mainly in rapid drying plus the germicidal action of certain substances in the smoke like acetic acid, creosote, and formaldehyde. The effects of smoking only penetrates partially into the meat, therefore uncooked sausage or other raw smoked meats may be dangerous for consumption.

Chemical Preservatives - Chemical preservatives are nothing more nor less than bacteriostatic substances and in the proportions commonly used may have little or no germicidal action. Upon general principles it is undesirable to add a chemical substance of whatever nature to food for the purpose of preserving, coloring or improving its appearance, since by such a method dangerous foods are often disguised. Benzoic acid and benzoate of soda are weak germicides at best. The reason why benzoic acid in moderate amounts is believed to be harmless is that the body possesses a special mechanism for taking care of this substance. The United States permits the use of benzoate of soda in quantities not exceeding 0.1% in certain foods, but the addition must be plainly labelled. Borax and boric acid are mild antiseptics. They are usually used together since in combination they are more efficient. These substances are not allowed as preservatives in food in the United States. Their effect on the body is not entirely clear, and since there are better methods of preserving foods, they are forbidden. Formaldehyde is injurious to the body and is absolutely forbidden in practically all nations as preservative for foods. Salicylic acid is a poison to the body and its use is prohibited in the U.S. by the Pure Food Act. Sodium nitrite is not known to be harmful in small quantities and is used to accentuate the red color of meat. Under circumstances where deception as to quality of meat is not practiced, sodium and potassium nitrate and some nitrites are allowed by the U.S. pure food regulations. Potassium permanganate is used on the surface of meat to destroy the surface evidence of decomposition. This should be strictly forbidden. Sodium fluoride is a good antiseptic but is poisonous to the body and should be forbidden from use in foods. Hydrofluoric acid is a good disinfectant but should be used as such, not in food but on utensils. Sodium sulphite, sodium bisulphate, and sulphurous acid are used principally upon fresh meats, where they act as a preservative and as a retainer of color. These chemicals are irritating and dangerous to the body and are forbidden from use in food by the U.S. Pure Food Act. Sulphur dioxide is employed for bleaching fruits and is allowed if labelled correctly, but when it is used in abnormal quantities for disguising excessive moisture contents of foods it is forbidden. Sodium bicarbonate is sometimes added to milk in order to neutralize the excess acid and delay souring. It is too ineffective as a germicide for general use as a food preservative. Hydrogen peroxide is perhaps one of the least dangerous of the chemical preservatives, and if used in milk will destroy Vitamin C. Arsenic is sometimes found in glucose when impure acids are used in its manufacture. It may

also contaminate certain aniline dyes and shellac which are used in cheap confectionary. Another source of arsenic in food is from insecticide sprays. The use of preservatives containing lead, arsenic or other substances known to be poisonous is strictly forbidden. Spices such as ginger, black pepper and cayenne pepper fail to prevent growth of bacteria, nutmeg and allspice have slight and temporary bacteriostatic properties. Cinnamon, cloves and mustard on the other hand have marked antiseptic powers.

The process of canning is practically synonymous with sterilization, and is, therefore, one of the best sanitary safeguards we have against parasites and bacterial injury in foodstuffs. The process of canning was discovered in Paris in 1804 to 1810 long before the days of bacteriology. The time and temperature for processing each article depend on various factors such as size of the pressure cooker, the food in the can, and the size of the can. Only fresh and sound fruits and vegetables should be put up. There is a fable extant, that once a can is opened and not emptied, the food in the can acquires injurious properties. The only time that such food becomes injurious is if it becomes contaminated and is not adequately refrigerated. The process of canning fortunately does not interfere seriously with most vitamins. Since oxidation is the factor which usually destroys vitamins, this is prevented by the canning process. The keeping qualities of canned foods vary with the product. In many instances they may be kept two or three years without appreciable change. All canned products keep better cold. Spoilage of canned food is generally classed as"swells", "flat sours", and "leaks". The ends of a swelled can bulge and when opened there is evidence of gaseous fermentation and spoilage. "Flat sour" is a term applied to acid decomposition without formation of gas. "Leaks" are usually due to defects in cans or sealing, or to corrosion. The factors responsible for unsatisfactory results with canned fruits and vegetables are mainly:(1) Use of unfit raw material (2) Use of unfit cans and glass jars (3) Carelessness in the matter of technic in cleanliness (4) Overfilling the cans (5) Carelessness in sealing the cans (6) Imperfect degrees of processing.

Practically all foods canned in the ordinary way contain some tin. Canned lobster and shrimp are relatively active as solvents of tin and therefore are packed in lacquered or enameled cans. Fortunately tin is not very toxic. The tin coating on cans is not always perfect and may be injured by manipulation, thus exposing the iron. The iron is attacked by some foods and may spoil the contents by discoloration or metallic taste. Glass containers have advantages but are more expensive.

Sanitary Distribution and Consumption - Foods may be safely produced and preserved, but may still become unsafe in the process of careless and insanitary distribution and consumption. Therefore the movement of the food from the producer or warehouse to the consumer must be under strict vigilance by public health authorities. The movement of food in trains,trucks and boats must be constantly supervised. Refrigeration must be adequate for perishable goods and ice must be correctly handled. Those food handlers who come directly in contact with food must be free of communicable diseases. Peddlers of foods must be as closely supervised as stationary establishments. Regulations for restaurants, soda fountains and grocery stores must be adequate both as to housing and to quality and methods of handling utensils. The sanitary requirements of eating and drinking establishments for maintaining a grade A rating according to the Code recommended by the U.S. Public Health Service are as follows:

Floors - The floors of all rooms in which food or drink is stored, prepared, or served, or in which utensils are washed, shall be of such construction as to be easily cleaned, shall be smooth, and shall be kept clean and in good repair. Public health reason - Properly constructed floors which are in good repair can be more easily kept clean than improperly constructed floors. Kitchen floors having an impervious surface can be cleaned more easily than floors constructed of wood or other pervious or easily disintegrated material, will not absorb matter, and are, therefore, more likely to be kept clean and free of odors. Clean floors are conducive to clean food handling methods.

Walls and Ceilings - Walls and ceilings of all rooms shall be kept clean and in good repair. All walls and ceilings of rooms in which food or drink is stored or prepared shall be finished in light color. The walls of all rooms in which food or drink is prepared or utensils are washed shall have a smooth, washable surface up to the level reached by splash or spray. Public health reason - Painted or otherwise properly finished walls and ceilings are more easily kept clean and are therefore more likely to be kept clean. A light colored paint or finish aids in the even distribution of light and the detection of unclean conditions. Clean walls and ceilings are conducive to clean food handling operations.

Doors and Windows - When flies are prevalent, all openings into the outer air shall be effectively screened and doors shall be self closing, unless other effective means are provided to prevent the entrance of flies. Public health reason - Flies may contaminate the food with disease organisms, thus nullifying the effectiveness of all other public health safeguards.

Lighting - All rooms in which food or drink is stored or prepared or in which utensils are washed shall be well lighted. Public health reason - Ample light promotes cleanliness.

Ventilation - All rooms in which food or drink is stored, prepared, or served, or in which

utensils are washed, shall be well ventilated. Public health reason - Proper ventilation reduces odors, condensation upon interior surfaces, and smudging of walls and ceilings.
Toilet Facilities - Every restaurant shall be provided with adequate and conveniently located toilet facilities for its employees conforming with the ordinances of the political unit. In restaurants hereafter constructed toilet rooms shall not open directly into any room in which food, drink or utensils are handled or stored. The doors of all toilet rooms shall be self-closing. Toilet rooms shall be kept in a clean condition, in good repair, and well lighted and ventilated. Hand washing signs shall be posted in each toilet room used by employees. In case privies or earth closets are permitted and used, they shall be separate from the restaurant building, and shall be of a sanitary type constructed and operated in conformity with the standards of the State Board of Health. Public health reason - The need for toilet facilities and the necessity for protecting the food from toilet contaminated hands and flies are obvious.
Water Supply - The water supply shall be easily accessible to all rooms in which food is prepared or utensils are washed, and shall be adequate, and of a safe sanitary quality. Public health reason - The water supply should be accessible so as to encourage its use in cleaning operations; it should be adquate so that cleaning and rinsing will be thorough; and it should be safe, sanitary quality in order to be suitable for drinking and to avoid the contamination of food and utensils.
Lavatory Facilities - Adequate and convenient hand washing facilities shall be provided including warm water, soap, and approved sanitary towels. The use of a common towel is prohibited. No employee shall resume work after using the toilet room without first washing his hands. Public health reason - The use of washing facilities and sanitary towels are essential to the personal cleanliness of food handlers.
Construction of Utensils and Equipment - All multi-use utensils and all show and display cases or windows, counters, shelves, tables, refrigerating equipment, sinks and other equipment or utensils used in connection with the operation of a restaurant shall be so constructed as to be easily cleaned and shall be kept in good repair. Public health reason - If the utensils and equipment are not so constructed that they can easily be cleaned, and are not kept in good repair, it is unlikely that they will be properly cleaned.
Cleaning and Bactericidal Treatment of Utensils and Equipment - All equipment, including display cases or windows, counters, shelves, tables, refrigerators, stoves, hoods, and sinks, shall be kept clean and free from dust, dirt, insects, and other contaminating material. All multi-use utensils used in the preparation or serving of food and drink shall be thoroughly cleaned and effectively subjected to an approved bactericidal process immediately following the day's operation. Drying cloths, if used, shall be clean and shall be used for no other purpose. Public health reason-Food cannot be kept clean and safe if permitted to come in contact with containers, utensils, and equipment which have not been properly cleaned and given bactericidal treatment. The diseases which this item is intended to guard against are those in which the infective agent appears in the saliva or other body discharges.
By approved bactericidal process is meant the application of any method or substance for the destruction of pathogens and all other organisms so far as practicable, and which, in the opinion of the health officer, is effective and does not adversely affect the equipment or the food or drink or the health of the consumer.
The cleaning may be accomplished by the use of warm water (110°F. to 120°F.) containing an adequate amount of an effective soap or detergent to remove grease and solids. The soapy wash water should be changed at sufficiently frequent intervals to keep it reasonably clean. Careful scraping or pre-rinsing of dishes to remove the gross food particles before washing will make it possible to keep the wash water clean for a longer time between changes and to maintain a sufficient concentration of the detergent.
After cleaning, all such utensils are effectively subjected to one or more of the following or other equivalent approved bactericidal processes:
Immersion for at least 2 minutes in clean, hot water at a temperature of at least 170°F. or for 1/2 minute in boiling water. Unless actually boiling water is used an approved thermometer shall be available convenient to the vat. The pouring of scalding water over washed utensils shall not be accepted as satisfactory compliance.
It is recommended that, wherever practicable, bactericidal treatment should be obtained through the use of hot water in the manner above described. For this method of bactericidal treatment two adjacent deep sinks should be provided and fitted with a porcelain, metal, or other impervious drainboard. If difficulty is experienced in obtaining clean looking glasses it is recommended that greater manual effort be applied, or that a more efficient detergent be tried, or that the rinse water be changed more frequently, or that a three compartment vat be used. After washing, the glasses, dishes, etc. should be placed in metal baskets and immersed in the hot water for the required period of time. Baskets may be lined with wooden strips to prevent marking of the chinaware. Upon removal from the hot water they should remain in the baskets until dry and then stored in such manner as not to become contaminated before again being used.
Where hot water is used for bactericidal treatment there shall be provided a hot water heater (preferably controlled by a thermostat) capable of maintaining a water temperature of at least 170°F. in the vat at all times during business hours. The heating device may

be integral with the immersion vat. It is considered that even in the case of roadside stands hot water may be obtained through the use of gasoline or kerosene stoves, which may, if the wash and rinse vats are correctly constructed, be placed directly thereunder.
Care shall be taken in the bactericidal treatment of containers by immersion in hot water or chlorine rinse to prevent the trapping of air in the container, thus preventing contact with the entire surface of the container. This may be accomplished by placing all glasses, cups, plates, and saucers, in a venting position so that air will not be trapped.
Immersion for at least 2 minutes in a lukewarm chlorine rinse containing at least 50 ppm of available chlorine if hypochlorites are used, or a concentration of equal bactericidal strength if chloramines are used. The rinse should be made up at a strength of 100 ppm or more of hypochlorites and shall not be used after its strength has been reduced to 50 ppm.

Solutions made from compounds containing chloramine or chloramine-T have a slower bactericidal action than hypochlorites containing equal concentrations of available chlorine. The former must therefore be made up to a sufficiently greater strength to produce a bactericidal effect within the required exposure period equivalent to that of the above hypochlorite concentration. The chloramine and chloramine-T concentration necessary will vary with the different compounds.
Chlorine solutions once used shall not be reused for bactericidal treatment on any succeeding day, but may be reused for other purposes.
Where chlorine treatment is used a three compartment vat shall be required, the first compartment to be used for washing, the second for plain rinsing, and the third for chlorine immersion; provided that for existing installations the second or rinsing compartment may be omitted if a satisfactory rinsing or spraying device is substituted. This will prevent the excessive consumption of chlorine by organic matter and washing compounds carried over from the washing compartment. The first basket of utensils will remain in the chlorine rinse for at least 2 minutes while the second basket is in the plain rinse and the third basket is being washed. Upon removal from the chlorine rinse the utensils may be rinsed in clean running water, if desired, and allowed to dry either in the basket or inverted on a drain shelf or tray.
Silver and silver-plated tableware should not be treated with chlorine as silver chlorides are formed which blacken the silver.
The health officer or sanitarian shall satisfy himself by frequent test that the chlorine rinse in actual use is of the required strength. The following test suitable for this purpose has been devised by the Sanitation Section of the United States Public Health Service:

The test for chlorine strength makes use of the fact that when the proper amount of o'tolidin is added to a chlorine solution containing 20 parts per million or more a precipitate is formed, except that in the case of certain chloramines the solution becomes cloudy at chlorine concentrations having a 2 minute bactericidal strength equivalent to at least the bactericidal strength of 20 parts per million of available chlorine in the form of hypochlorite.
The testing outfit consists of two test tubes 7/16 by 4 inches, one of which contains orthotolidin. (For composition of o'tolidin solution see Standard Methods of Water Analysis published by the American Public Health Association). The other is fitted with a medicine dropper and is used for testing the chlorine solution. It is etched at the 2 cc and 5 cc levels so as to make possible the dilution of the solution to be tested to two-fifths of its original strength, thus diluting an original solution of 50 parts per million or more to one of 20 parts per million or more, which, as above stated, is the critical point for the formation of the precipitate when hypochlorites are tested. Before any tests are made with the apparatus the medicine dropper should be tested to determine whether it delivers drops of the proper size. To do this, simply count the number of drops required to fill to the first mark of the testing tube. If the number required lies between 30 and 50, the dropper is satisfactory. If not, discard it and secure one of the proper size.
The test procedure is as follows: Rinse the testing tube and its dropper thoroughly with clean water. Fill the testing tube to the lower mark with the chlorine solution to be tested, using the dropper for this purpose. Avoid including floating particles. Fill to the second mark with clean water, using the dropper for this purpose. Add 1 drop of orthotolidin. Hold the upper part of the testing tube firmly with one hand and tap the lower end of it sharply 50 times with one or two fingers of the other hand. If, in the case of hypochlorites, reddish or brownish particles separate out within 5 minutes, the solution tested has a bactericidal strength for a 2 minute exposure equivalent to at least the bactericidal strength of 50 parts per million of available chlorine in the form of hypochlorite.

In order to determine whether a certain commercial preparation is strong enough for dairy use when mixed as directed on the label, the inspector should mix a portion, then dilute half and half, and test for 50 parts per million by means of the above described test. If a precipitate appears, the directions upon the label result in a solution containing at least 100 parts per million in the form of hypochlorites or the bactericidal equivalent thereof and may be approved. Otherwise, such larger quantity of the stock solution should be used as will give a satisfactory test.

Exposure in a steam cabinet equipped with an indicating thermometer located in the coldest zone to at least 170°F for at least 15 minutes, or to at least 200°F. for at least 5 minutes. For a discussion of steam cabinets see item 14r of the U. S. Public Health Service Milk Code. Steam cabinets should be provided with a valve to permit the discharge of cold air when steam is admitted. Exposure in a properly designed oven or hot air cabinet equipped with an indicating thermometer located in the coldest zone to hot air at a temperature of at least 180°F. for at least 20 minutes [1].

Equipment that is too large to immerse may be treated (1) with live steam from a hose, in the case of equipment in which steam can be confined, (2) by boiling water rinse, or (3) by spraying or swabbing with chlorine solution of approved strength.

Health officers or sanitarians should check with a thermometer [2] the actual temperatures used in the methods which employ heat as the bactericidal agent. If washing machines are used the temperatures of both the wash water and the rinse water should be checked. For all bactericidal processes the actual period of exposure to the temperature or the chlorine rinse should be checked to determine compliance. To promote adequate exposure, restaurants should be encouraged to provide a sufficient supply of glasses, dishes, cups, and tableware, particularly where the process employed requires a long exposure period.

Drying cloths, if used, shall be clean and shall be used for no other purpose. It is recommended that wherever possible utensils be permitted to drain dry without the use of drying cloths.

In washing machines the use of strong alkalis and higher wash water temperatures make it possible to employ a shorter exposure period for the final treatment. In such cases the above standards for bactericidal treatment will not apply, and the health officer should resort to other methods, such as the following, for determining actual results obtained.

Where bacteriological laboratory facilities are available, the following proposed standard procedure for bacteriological examination of cleansed and disinfected utensils, provisionally established by the Subcommittee on Standard Methods for the Examination of Dishwashing Devices of the American Public Health Association [3], is recommended:

By the multiple spoon test. Ten spoons are placed in a pint jar containing 200 cc of sterile salt solution and agitated for 2 minutes.

By the multiple glass test. Ten glasses are examined by passing a damp swab three times around the inside rim and three times around the outside rim of each glass, and the swab is agitated between the swabbing of each successive glass in a test tube containing 10 cc of salt solution. Thus the test tube contains the pooled washings from 10 glasses.

By the multiple plate test. Ten plates are examined by passing a damp swab over a four square inch area of each plate and the swab is agitated between the swabbing of successive plates in 10 cc of sterile salt solution.

The bacterial suspensions from the three foregoing types of utensils are each plated in the usual manner and the number of organisms per utensil is thereby determined.

The bacterial count should not exceed 500 organisms per utensil surface area examined.(More recent work indicates that a standard of 100 is readily attainable, and this standard is therefore recommended).

STORAGE AND HANDLING OF UTENSILS AND EQUIPMENT

"After bactericidal treatment no utensils shall be stored except in a clean dry place protected from flies, dust, or other contamination, and no utensils shall be handled except in such a manner as to prevent contamination as far as practicable. Single service utensils shall be purchased only in sanitary containers, shall be stored therein in a clean dry place until used, and shall be handled in a sanitary manner. Public health reason - If utensils and equipment are not protected from contamination the value of bactericidal treatment may be nullified. The following instructions concerning disinfection of utensils used in food handling establishments are recommended by the Louisiana State Department of Health: "To managers and proprietors of restaurants, ice cream parlors, soda fountains, beverage stands, and all places preparing and serving food or drink to the public".

"The State Sanitary Laws now Require Disinfection of Dishes, Glasses, Knives, Forks, Etc.

The State Sanitary regulations require that eating and drinking utensils must be: (1) Washed in hot water with alkaline washing powder (2) Rinsed in clean running water (3) Disinfected by immersing in: chlorine disinfecting solution (containing at least 100 parts per million of chlorine) for over two minues, or boiling water (at over 170°F)for over two minutes.(4) Drained until dry in clean racks or baskets.

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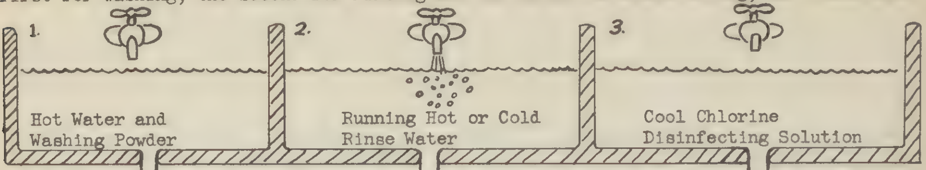
[1] See Studies of the Bactericidal Treatment of Milk Cans in Hot-air Cabinets, Public Health Reports, March 4, 1938 (Reprint No. 1912).

[2] The following specifications for inspectors' milk temperature thermometers are designed to make this a general purpose thermometer suitable for determining not only refrigeration temperatures but also bactericidal treatment temperatures at dairies and restaurants.

[3] A.P.H.A. Year Book, 1936-1937, P. 48.

"Your sink should be made with three compartments with hot and cold water available, the first for washing, the second for rinsing and the third for disinfecting, as illustrated



Containers for disinfecting solution must be provided, unless sufficient hot water sterilizers are on hand.

"To make the disinfecting solution add one ounce (two large tablespoonsful) of fresh solution of chlorinated soda, U.S.P., to each gallon of water. Fresh solution of chlorinated soda, U.S.P., may be obtained from any wholesale drug house. It must be kept in a cool place,tightly corked, and loses strength after about thirty days. We trust that future inspections will find you adequately equipped for complying with the requirements".

Disposal of Wastes - All wastes shall be properly disposed of, and all garbage and trash shall be kept in suitable receptacles, in such manner as not to become a nusiance. Public health reason - All garbage, refuse, and liquid wastes resulting from the normal operation of a food or drink establishment should be properly disposed of so as not to become a nuisance or a public health menance.

Refrigeration - All readily perishable food or drink shall be kept at or below 50°F. except when being prepared or served. Waste water from refrigeration equipment shall be properly disposed of. Public health reason - Usually the bacteria in food are harmless, and if this were always true there would be no reason to refrigerate food except to prevent spoilage. There is, however, no way to be sure that pathogenic bacteria have not entered the food (even though observance of the other items of this ordinance will much reduce this likelihood). The likelihood of contracting disease may be increased when the food contains large numbers of disease producing organisms. For this reason perishable foods should be kept cold so that any small number of disease producing bacteria which may have entered will not be permitted to multiply.

Wholesomeness of Food and Drink - All food and drink shall be free from spoilage. All milk, fluid milk products, ice cream, and other frozen desserts served shall be from sources approved by the health officer. Milk and fluid milk products shall be served in the original containers in which they were received from the distributor or from a bulk container equipped with an approved dispensing device: Provided, that this requirement shall not apply to cream, which may be served from the original bottle or from a dispenser approved for such service. All oysters, clams, and mussels shall be from approved sources. Public health reason - Unwholesome or spoiled food or drink may be harmful to the consumer.

Storage and Display of Food and Drink - All food and drink shall be so stored and displayed as to be protected from dust, flies, vermin, unnecessary handling, droplet infection, overhead leakage, and other contamination. No animals or fowls shall be kept or allowed in any room in which food or drink is prepared or stored. All means necessary for the elimination of flies shall be used. Public health reason - Food or drink not properly protected from contamination may become a public health hazard.

Serving of sliced butter and cracked ice shall not be by direct contact with fingers or hands. Bottled milk and other beverages in non-leakproof containers shall not be submerged in water for cooling. Food or drink shall not be stored on floors which are subject to flooding from sewage backflow, such as those below street level. On new construction the location of a restaurant in a basement below the surface of the ground shall be discouraged. All unwrapped or unenclosed food and drink on display are protected by glass or otherwise from public handling or other contamination, except that approved hand openings for self-service may be permitted on counter fronts.

Dustless methods of floor cleaning are used, or dustarresting sweeping compounds and push-brooms are employed; and all except emergency floor cleaning is done during those periods when the least amount of food and drink is exposed, such as after closing or between meals. No animals or fowls are kept or allowed in any room in which food or drink is prepared or stored.

Cleanliness of Employees - All employees shall wear clean outer garments and shall keep their hands clean at all times while engaged in handling food, drink, and utensils during handling.

Miscellaneous - The premises of all restaurants shall be kept clean and free of litter or rubbish. None of the operations connected with a restaurant shall be conducted in any room used as living or sleeping quarters. Adequate lockers or dressing rooms shall be provided for employees' clothing and shall be kept clean. Soiled linens, coats, and aprons shall be kept in containers provided for this purpose.

Protection Against Misrepresentation and Injurious Foods - The federal government and the various states protect the public against harmful foods (and drugs) and fraudulent practices

by defining the conditions under which extraneous substances can be put into foods and specifying the type and grade of foods which can be produced and sold. This has already been discussed. But in order to further guarantee protection, the government further requires that foods should be identified as to type, contents, producer, composition of any extraneous substance added to it, and as to the processing of the food by labeling. The Louisiana State Food, Drugs and Cosmetic Act defines misbranded food as follows: A food shall be deemed to be misbranded if it has been found to be such by any department of the United States Government, or:

(a) If its labeling is false or misleading in any particular.

(b) If it is offered for sale under the name of another food.

(c) If it is an imitation of another food, and its label fails to bear, in type of uniform size and prominence, the word "imitation" and immediately thereafter, the name of the food imitated.

(d) If its container is so made, formed, or filled as to mislead the purchaser.

(e) If in package form unless it bears a label containing (1) the name and place of business of the manufacturer, packer, seller, or distributor; and (2) an accurate statement of the quantity of the contents in terms of weight, measure, or numerical count: Provided, that under subdivision (2) of this paragraph reasonable variations shall be permitted, and exemptions as to small packages shall be established, by regulations prescribed by the Board.

(f) If any word, statement, or other information required on the label under any provision of this Act is not prominently placed thereon in such a manner as to be easily seen and in such terms as to be readily understood by purchasers and users of such articles under customary conditions of purchase and use, due consideration being given to the size of the package.

(g) If it purports to be or is represented as a food for which a definition and standard of identity has been prescribed by regulations as provided by Sections 5 and 15, and (1) it fails to conform to such definition and standard, or (2) its label fails to bear the name of the food prescribed in the definition and standard permits optional ingredients other than spices, flavors, and coloring, the common names of such optional ingredients as are present in such food.

(h) If it purports to be or is represented as a food for which a standard of equality or fill of container has been prescribed by regulations as provided by Section 5 and 15, and its quality or fill falls below such standard of quality or fill of container its label fails to bear a statement, in such manner as the regulations specify, showing that it falls below such standard of quality or fill of container.

(i) If it is not subject to the provisions of paragraph (g) of this section and its label fails to bear (1) the common or usual name of the food, if any there be, and (2) in case it is fabricated from two or more ingredients the common or usual name of each such ingredient; except that spices, flavors, and coloring, other than those sold as such, may be designated as spices, flavors, and colorings without naming each. Provided, that, to the extent that compliance with the requirements of sub-division (2) of this paragraph is impracticable because of variations in ingredients usual to good manufacturing or packing practice, or is impracticable for any other reason; exemptions shall be established by regulations promulgated by the Board. Such sub-division (2) shall not apply to any proprietary food the ingredients of which have been fully and correctly disclosed to the Board if compliance with such sub-division would give competitors information they could not otherwise obtain. The Board shall establish regulations for carrying this Act into effect and publish from time to time the list of ingredients required in this sub-section to be declared on the label provided, however, that such lists shall be within the class of ingredients required to be declared on the label under this sub-section.

(j) If it purports to be or is represented for special dietary used, such as by infants, or invalids or for other special nutritional requirements, and its label fails to bear, statements concerning its vitamin, mineral, and other dietary properties which fully inform the purchaser as to its nutritional value. The Board shall establish regulations for carrying this sub-section (j) of Section 4 into effect including administrative regulations covering vitamin, mineral and other dietary properties, provided that such regulations shall be established in cooperation with the United States Public Health Service and particularly in the work of that service connected with pellagra and other dietary diseases and the feeding of children to the end that the inspection to determine correct labeling shall fully conform to the work of the Public Health Service and to the extent that such is included within the expressed provision therein for labeling.

(k) If it bears or contains any artificial flavor, artificial color, or chemical preservative, and it fails to bear a label stating that fact.

(l) The Board is hereby authorized to promulgate regulations exempting from any labeling requirement of this Act small open containers of fresh fruits and fresh vegetables and also food which is, in accordance with the practice of the trade, processed, labeled, or repacked in substantial quantities at establishments other than those where originally processed or packed, on condition that such food is in conformity with the provisions of this Act upon removal from such processing, labeling, or repacking establishment.

The government further protects the public by defining penalties for those who violate the

above regulations.

ADMINISTRATIVE PROCEDURE FOR EPIDEMIOLOGICAL CONTROL

The registration of producers and their products and the accompanying collection of fees serves the purposes.
1. Financing the governmental administrative and functional setup for carrying on the work of the food, drug and cosmetic control.
2. Analyzing the material and process of production for the purpose of evaluating their relation to health and preventing the health hazards before the population is subjected to them.
3. Allowing the sanitarian or health officer to seek out, in the course of their routine inspections, those who make a practice of evading the regulations of the health laws.
Registration and fee collections are thus justified. They aid in the regulating activity of the health department. The day may come, of course, when fee collections will be dispensed with, but that could happen only when appropriations toward public health work become adequate. But the function of registration must be practiced so long as private enterprise exists.
The labeling of foods is not only practiced for the purpose of allowing the public to use its descrimination ability in choosing the various brands of foods, but also to serve as a weapon in the epidemiological efforts of the health department to identify foods that might be found to be injurious to the public. Dating of food products that are of a perishable nature is also practiced for information to the public and for aiding the health department to insure fresh food to the public. Advertising is subject to the same regulations as labeling.

LEGAL POWERS OF PUBLIC HEALTH AGENCIES TO PRACTICE PROTECTIVE MEASURES IN GOOD CONTROL

The powers of health agencies have their sources in federal, state, and local legislation. The federal government's power in food control comes mainly from its constitutional rights of regulative power over interstate and foreign intercourse. The state's power in food control comes from its constitutional rights as an autonomous unit except when federal authority may supervene. The local or municipal power in food control comes from the rights granted it by charter from the state.

In order for a health department to insure safe handling of food it must not only be able to obtain laws defining techniques and other specifications, but it must have the power to carry into action the contents of the laws. Therefore, it becomes necessary for the health officer or his representative to have the authority to - (1) Enter an establishment to perform an inspection, (2) Collect samples of foods, drugs, or cosmetics, (3) Seize and condemn and destroy unsafe or misrepresented articles, (4) Demand injunction procedures, (5) Examine records describing shipments of food, (6) Demand physical examination of food handlers.

The Louisiana State Food, Drugs and Cosmetic Act of 1936 gives power of entry and inspection in the following words: "In order to prevent commerce in adulterated or misbranded foods, drugs, devices or cosmetics for the purposes of safeguarding the public health and preventing deceit upon the purchasing public, officers or employees duly designated by the Board, after making reasonable request, are authorized (1) to enter any factory, warehouse, or establishment in which food, drugs, devices, or cosmetics are manufactured, processed, packed or held for storage or shipment in commerce or are held after shipment,or to enter any vehicle being used to transport such food, drugs, devices, or cosmetics in commerce; and (2) to inspect such factory, warehouse, establishment, or vehicle and all pertinent equipment, finished and unfinished materials, containers, and labeling therein. Any such owner, operator, or custodian who refuses such reasonable request shall be guilty of a misdemeanor and shall on conviction thereof, be subject to the penalties prescribed by this Act."
The right of sampling is given as follows:
"The Board is authorized (1) to conduct examinations, and investigations for the purpose of this Act or through officers and employees of the Board; (2) to require all manufacturers, packers, or proprietors of processed foods, proprietary or patent medicines, prophylactic devices and cosmetics, in package form, to register each separate and distinct product annually with the Board and to supply this Board with a sample of each such product upon request; and to assess the manufacturers, packers, or proprietors of such products an annual examination and investigation charge ..."
The right of seizure is declared as:
"Any article of food, drug, device, or cosmetic that is adulterated, misbranded, or unregistered, or that has been manufactured, processed, or packed in a factory or establishment, the operator of which did not, at the time of manufacture, processing, or packing, hold an unsuspended valid permit, if so required by regulations...., shall be liable to seizure and condemnation by the Board or such officer or employee as it may designate for the purpose.

"Any food, drug, device, or cosmetic condemned under this section shall be disposed of by destruction or sale as the Board may . . .direct'

The authority to demand injunction proceedings is stated as follows:

"In order to avoid multiplicity of criminal prosecutions, the district courts are hereby vested with jurisdiction for cause shown, to restrain by injunction, temporary or permanent, any person from the repetitions (1) introduction or causing to be introduced into commerce any adulterated, misbranded, or unregistered food, drug, device, or cosmetic: or (2) dissemination of or causing to be disseminating a false advertisement by any means for the purpose of inducing, directly or indirectly, the purchase of food, drugs, device, or cosmetics in commerce. In such injunction proceeding it shall not be necessary to show on the part of such person an intent to continue the offense".

The right to examine records describing shipment of foods is given as:

"For the purpose of enforcing the provisions of this Act, carriers engaged in interstate commerce, and persons receiving food, drugs, devices, or cosmetics in interstate commerce, shall, upon the request of an officer or employee duly designated by the Board, permit such officer or employee to have access to and copy all records showing the movement in interstate commerce of any food, drug, device, or cosmetic, and the quantity, shipper, and consignee thereof.."

The right to demand physical examination of food handlers:

The Louisiana Sanitary Code provides that "No person who is affected with any infectious disease in a communicable form shall work or be permitted to work in any place where food or drink is prepared, served, stored, sold or offered for sale. All food handlers are required to have a medical certificate from the local board of health." Chapter XIII-Article [illegible]-c. General stores may sell in the original package proprietary articles which do not contain poisonous nor habit-forming ingredients. Articles listed below are forbidden to be sold by general stores or by wholesalers to general stores:

Abortifacients, acid, carbolic crystalized; acid, muriatic (except in original package for technical use); acid, nitric; acid, oxalic; acid, sulphuric; alcohol, methyl (except in original package for technical use); ammonia water stronger, antimony and its preparations, apiol; arsenic and its preparations (except in original package for use as insecticide), belladonna, its preparations, alkaloids and salts; bitter almond oil, cannabis indica, caulophyllum, cantharides and its preparations, chloroform, chloral hydrate, cocaine and its derivatives, codeine, copper and its salts (except in original package for insecticide), cotton root, croton oil, cyanide of potassium (except in original package for technical use), cyanide of zinc, digitalis and its preparations, ergot, ether, eucaine and its preparations, gelsemium, hemlock, its preparations; alkaloids and salts; hyoscyamus, lead salts (except lead acetate for technical use), mercury and its salts, excepting calomel and mercurial ointment; morphine and its derivatives (except in original proprietary package containing not more than 1/4 grain per fluid ounce or 1/8 grain of heroin per fluid ounce), nickel and its salts, nux vomica, its fluid extract and tincture; oil pennyroyal, oil savin, opium and its derivatives (except paregoric in original package containing not more than 2 grains of opium per fluid ounce also excepting Dover's powder (ipecac and opium); pennyroyal herb, physostigma, its preparation and salts; phosphorus and its preparations (excepting pastes used as insecticides), potassium hydroxide, rue, scopola, its preparations and salts;serums, sodium hydroxide (except in original package in preparations for cleaning),strophanthus and preparations, strychnine and its preparations, tincture iodine, tincture aconite, vaccine-bacterial, veratrum, its preparations and salts; venereal prophylactics, zinc acetate,zinc chloride, zinc phosphate, zinc sulphate.

Proprietary medicines, bearing labels or containing statements that the article is used for the cure of mitigation of disease, which contain alcohol in excess of amount needed to preserve or hold ingredients in solution.

Preparations containing any of the above ingredients in amounts which may make articles habit-forming or poisonous.

Provided that tincture of iodine in bottles containing not more than one ounce may be sold by general stores or by wholesalers to general stores. A record of each sale by retailer to be kept.

Provided further, that industries or manufacturers may purchase direct from wholesaler tincture of iodine in pint package.

BOTTLED WATER AND OTHER BOTTLED CARBONATED BEVERAGES

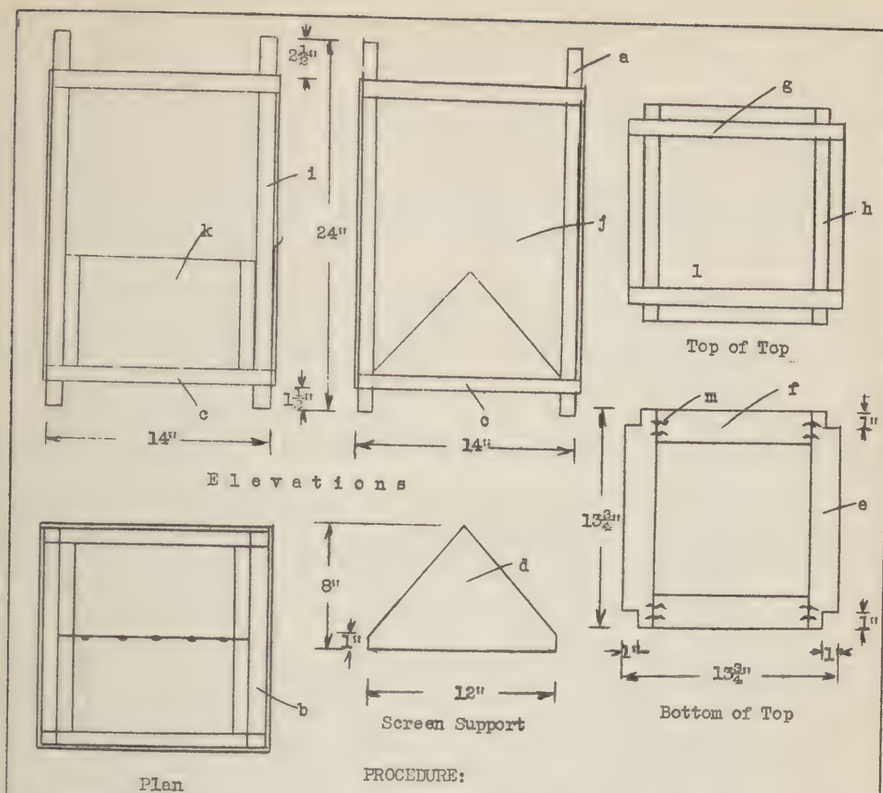
Regulations of the Louisiana Sanitary Code

Location and Use of Building: The building, or portion thereof, employed for the manufacture of bottled water and other bottled carbonated beverages, shall be used for no other purpose and shall be so located as to be protected from objectionable surroundings.

Floors: The floors of all rooms shall be of concrete, tile, or other impervious material with a smooth surface and maintained in a clean and sanitary condition. They shall be graded and sloped to properly trapped drains.

Walls and Ceilings: Walls and ceilings in the syrup and bottling rooms shall be of hard,

sound materials with smooth, easily cleaned surfaces, frequently painted and maintained clean. Light and Ventilation: All rooms shall be adequately lighted and ventilated. Protection Against Flies: All openings to the outer air shall be screened or otherwise protected where necessary against entrance of flies. The syrup room shall be especially protected against flies. Syrup Room: The syrup room shall be separately enclosed, well ventilated and lighted, provided with sinks, hot and cold water, thoroughly protected against vermin, flies, dirt, and dust, and so constructed as to be easily cleaned. Water and Sewer Connections: Running water of satisfactory quality shall be easily accessible to all parts of the plant. Adequate provision shall be made for prompt removal and proper disposal of waste water and sewage. If a separate water supply is used for any purpose in the plant, there shall be no connection between that supply and the potable supply used for manufacturing. Toilets and Washrooms: Adequate toilet facilities and lavatory facilities shall be provided and shall be maintained in a clean and sanitary condition. Toilet and washroom fixtures shall be so constructed and so operated as to prevent return flow or back siphonage from such fixtures into the water supply. Toilet rooms shall have no direct connection with rooms used for manufacturing or bottling. Washing, Carbonating, Filling and Crowning Machinery: Every plant manufacturing bottled beverages shall be equipped with suitable mechanical bottle washing apparatus and with approved machines for carbonating, filling, and crowning, so that these operations are performed in such manner as to prevent any part of the operator or his clothing from coming in contact with those surfaces of the bottle which come in contact with the beverage. Bottle washing machines shall be so constructed and operated as to prevent back siphonage or return flow into the water supply lines. Conveyors and Cases: Conveyors and cases shall be maintained in a clean and sanitary condition. Syrup Making Equipment: All vats, jars, mixing and storage tanks, pipe lines, filters, and other apparatus employed in the preparation of syrups, shall be of sanitary construction and lined with materials resistant to the action of syrup ingredients. Water Clarification Equipment: Electrical or chemical coagulation devices and filters employed for clarification of water shall be of types approved by the State Board of Health, shall not be operated beyond their rated capacity, and shall be maintained in a clean, wholesome, and sanitary condition at all times. Miscellaneous Equipment: Every plant manufacturing bottled carbonated beverages shall be adequately provided with thermometers, acid and sugar hydrometers, gas volume testers, and apparatus for ascertaining the alkalinity and causticity of the soaker solution in bottle washing. Plant Layout: Where practicable, the operations of bottle washing and filling, compounding and mixing of syrups, and shipping, shall be performed in separate rooms. Where this is not feasible, the various operations shall be located in the available space in such manner as not to interfere with one another. Bottle Washing: Hand bottle washing, except as a preliminary to subsequent mechanical washing, is prohibited. All bottles shall be thoroughly cleaned and sterilized, immediately before filling, by means of a suitable automatic mechanical washing machine. Preparation of Syrups: Syrups shall be prepared in a clean manner, and every precaution shall be taken against contamination or absorption of deleterious substances during the process of preparation and subsequent storage. Filling and Crowning: Manual filling or crowning is prohibited. Bottles shall be filled and capped with automatic machinery and the operator or his clothes shall not come in contact with any portion of the bottle or machinery which might result in contamination of the product. Storage of Crowns: Crowns shall be stored in dust-proof containers. Preparation and Storage of Colors: All non-alcoholic colors shall be prepared in small batches, sterilized immediately before use, and stored so as to be protected against dust. Storage of Finished Goods: The finished products shall be stored in such manner as not to interfere with the sanitation of the bottling room. Refuse and Rubbish: Broken bottles and such other refuse and rubbish as may be found in returned cases, etc., shall be placed in suitable containers and properly disposed of. Sterilization and Cleaning of Apparatus: All pipe lines, apparatus and containers employed in the manufacturing processes shall be thoroughly washed, cleaned and sterilized, at frequent intervals, so as to be maintained at all times in a clean and sanitary condition. Steam, hot water, chlorine or other equally efficient agents are permissible for sterilization. Water: The water employed in the manufacture of beverages and for rinsing bottles, or other containers, shall be free from substances deleterious to health and shall conform to the regulations of this Code and to the standards of the Louisiana State Board of Health for Potable Water. Sugar: The sweetening agents employed in the manufacture of bottled carbonated beverages shall consist exclusively of edible sugar such as sucrose, dextrose, invert sugar, and levulose, singly or in combination, or other suitable and nutritious carbohydrates. The use of saccharine is prohibited. Preservatives: No antiseptic, disinfectant, or preservative prohibited by food and drug or health laws shall be used in beverages. Acid and Flavors: Citric, tartaric, or other edible organic acids, and their salts may be used. Mineral acids, other than phosphoric acid or its salts, are prohibited from carbonated beverages. Acids and flavors shall be stored in suitable containers, properly labeled, and protected against contamination. Colors: Only caramel, U.S. certified coal tar, or approved begetable colors shall be used. Appearance, Sanitary Habits and Health of Employees: All persons engaged in the mixing of syrups, filling of bottles, or in any other capacity which brings them in contact with the ingredients or containers of beverages, shall be free from communicable disease or insanitary habits, and shall be of clean, neat appearance and shall wear clean clothes.



PROCEDURE:

Use rough lumber, full 1" thick, preferably Cypress.
Assemble skeleton frame, using pieces a, b and d. Attach wire k to d's. Wrap wire j to skeleton frame, using plenty of tacks. Place strips c and i, overlapping at corners. Assemble top, being sure that it fits snugly at corner posts. Punch 5 - $\frac{1}{4}$" holes in top of V-screen to let flies get into trap.

MATERIAL LIST

a - 4 pcs	1" x 1" x 24"	
b - 8 pcs	1" x 1" x 12"	
c - 8 pcs	$\frac{1}{4}$" x 1" x $14\frac{1}{2}$"	
d - 2 pcs	1" x 8" x 12"	
e - 2 pcs	1" x 2" x $13\frac{3}{4}$"	
f - 2 pcs	1" x 2" x $9\frac{3}{4}$"	
g - 2 pcs	$\frac{1}{4}$" x 1" x $13\frac{3}{4}$"	
h - 2 pcs	$\frac{1}{4}$" x 1" x $9\frac{3}{4}$"	
i - 8 pcs	$\frac{1}{4}$" x 1" x 18"	
j - 1 pc	20" wide x 4'-8")	16 mesh screen,
k - 1 pc	20" wide x 11")	galvanized or
l - 1 pc	11" x 11")	bronze wire.
m - 8	corrugated fasteners	
	necessary nails and tacks	

8/40	Drawn	SHN

FLY TRAP

Bureau of Sanitary Engineering
Louisiana State Board of Health

References:
1. Preventive Medicine and Hygiene - Rosenau
2. A Half Century of Public Health - Ravenel
3. Louisiana Sanitary Code.
4. Louisiana Food, Drugs, and Cosmetic Act
5. U.S.P.H.S. Ordinance and Code Regulating Eating and Drinking Establishments
6. Federal Food, Drugs, and Cosmetic Act of 1938.
7. Sanitary Inspector's Handbook - Clay.
8. Amendment to Food, Drugs, and Cosmetic Act of 1938 - passed by the regular session of the Legislature 1942.

Meat Control

DEFINITIONS:
"Meat" means the flesh of cattle, swine, sheep, or goats including meats which have been cured and smoked and edible offal and fat which is sold or intended for sale for human consumption, but does not include meats that have been cooked or otherwise prepared.

"Meat Products" include meats packed in air tight containers, cooked and dried meats, intestines and parts prepared in the form of sausage casings, rendered animal fats except in margarine, pies, sausage, and other prepared or manufactured articles of food containing any meat or cooked or dried meat other than fat.

"Carcass of Meat" is the skeleton with its muscles and membranes and also the kidneys and fat surrounding them.

"Offal" includes the head, tongue, feet, skin, and all internal organs except the kidneys.

TRADE TERMS FOR ANIMALS ARE:
Cattle: Bull is an entire male; Ox is a castrated male; Steer is a castrated male up to 1½ to 2 years of age; Stirk is a male or female, entire or not, about 1 year of age; Bull calf is an entire male calf; Heifer calf is a female calf; Heifer is a young cow before calving; Cow is a female after calving.
Sheep: Ram is an entire male; Tup is an entire young male; Wether (or widder) is a castrated male; Ewe is a female after lambing; Gimmer is a female before lambing; Ewe Lamb is a young female; Teg is a young sheep, either sex, entire or not.
Pig: Boar is an entire male; Hog is a castrated male; Porker is a young pig, either sex, entire or not; Sow is a female after having had a litter; Gelt is a female not having had a litter.
Goat: Billy is an entire male; Wether is a castrated male; Nanny is a female; Kid is a young goat, either sex.
Stag is a bull, ram, or goat, castrated at maturity.
Store Cattle, sheep or pigs are animals kept for breeding, or if for market, not yet fatted.

INSPECTION:
The flesh of food animals may be objectionable or harmful through disease or parasite infection. The meat of healthy animals may develop noxious qualities after slaughter through deterioration or infection during unsanitary handling. Not every disease makes the flesh of an animal unsafe or unfit for food. Diseases of a localized character, showing no signs of septic infection such as fever and wasting may not require condemnation of the meat, but it requires a trained inspector or veterinarian to determine what animal or meat is fit for consumption. It is, however, sometimes well worth the sanitarian to know some of the more easily recognizable signs of a sick animal, such as (1) rough or "staring" coat, (2) dry nostrils or covered with foam, (3) heavy or droopy eyes, (4) protruding tongue, (5) labored breathing, (6) slow and difficult movements, (7) diarrhea or blood stained urine, and (8) tendency of animal to isolate itself from the herd.

The prevention of infections and poisoning from meat and meat food products depends: (1) upon the health of the animal, (2) upon the mode of death, (3) upon the method of butchering, preserving and handling the flesh.

Competent inspection at places of slaughter will discover the first appearance of rinderpest, foot and mouth diseases, Texas fever or other epizootic; or herd disease such as tuberculosis, actinomycosis, hog cholera, Bang disease. Effective measures may be instituted at once and great economic loss averted. Meats should be inspected immediately after slaughter, or as soon as possible after.

The first essential of a good meat inspection service is to concentrate all slaughtering in central abattoirs. This simplifies inspection and sanitary control and protects the consumer. This method is only partially realized in the United States, and far from realization in Louisiana. The United States Federal Meat Inspection Law, approved in 1907, and last amended in 1930, provides for the inspection of cattle, sheep, goats, swine and in a restricted way of horses (Louisiana allows no slaughtering of horses for use as food), the meat or products of which animals are to enter interstate or foreign shipment. The law is administered by the Bureau of Animal Industry, United States Department of Agriculture.

The purpose of a meat inspection service is to: (1) Eliminate diseased or otherwise unsound meat, (2) require cleanly and sanitary precautions in the preparation and processing of foods composed wholly or in part of meat, (3) prevent the use of harmful dyes, preservatives,

chemicals or other deleterious substances, and false misleading labels and statements.

Antemortem inspection is done to segregate sick cows before slaughtering. All suspected and rejected animals are properly tagged or marked and certificates are given by the State or Federal Inspector for cattle passed. Cows showing signs of advanced pregnancy are also rejected as unfit for food. Postmortem inspections are made to eliminate those diseased animals which are not found on antemortem inspection. Diseases and conditions for which condemnations are made on either antemortem or postmortem inspections are very many and require trained personnel to diagnose. In 1952, the Federal Meat Inspection Service condemned 221,88? animals in postmortem inspections, in which group of animals over 40 diseases or conditions were found, the most prevalent of which were tuberculosis, pneumonia, pleurisy, enteritis, peritonitis, septicemia, pyemia, hog cholera, icterus, tumors, abscesses, arthritis, bone diseases, emaciation, contamination, leukemia, injuries, immaturity, tape worms, lymphadenitis, asphyxia, actinomycosis.

Certain important precautions should be taken before slaughtering. Animals should not be fed for about twenty-four hours before slaughtering in order to insure clean intestines and good flavored meat. They should not be excited since this produces poor bleeding which mars the appearance of meat and disposes it to quicker decay. After slaughtering, proper cleaning is important. Entrails should be removed as quickly as possible. Thorough cooling rapidly after slaughter is necessary.

INSTRUCTIONS TO MEAT MARKET OR MEAT PACKING PLANT OPERATORS, BY LOUISIANA STATE DEPARTMENT OF HEALTH

Plain ground fresh meats are not considered processed foods within the meaning of Section 17 of 1936. Hamburger and pork sausage, plus salt or other seasoning, are not considered processed foods and would not require registration. Hamburger should consist of nothing except ground beef, with or without salt or other seasoning. A mixture of ground beef and ground pork must not be sold as hamburger, but may be sold as beef and pork sausage, or pork and beef sausage, depending on whether the product contains over 50% beef or 50% pork.

When any flour, cereal product, dry skim milk powder, or other dry adulterant, is added to sausage, it must not be added in excess of 2% (2 pounds of flour to 100 pounds of meat).Also, when flour or any other dry adulterant is added to sausage meat, there must be a sticker, stamp or label added to, or attached to, the package of sausage meat at time of sale,stating "pork sausage", "pork and beef sausage", or "beef and pork sausage", as the case may be; and the added statement, "contains added cereal", "contains added dry skim milk powder", or similar information. The terms, "country", "country style", or similar words, cannot be used except for sausage which contains nothing but ground pork with salt or other seasoning, and which is free from any added dry adulterant. Any sausage meat to which has been added any flour, cereal, dry milk powder, or other added dry adulterant, so that it becomes a compound food, is considered a processed food, under the terms of Section 17, Act 142 of 1936, and must be registered with the State Board of Health. In applying for registration the application should be accompanied by a copy of the sticker, stamp or label which is used to mark the product as containing "added cereal" or other dry adulterant.

The use of any sulphite preparation in ground meats is a direct violation of Section 20,Act 142 of 1936. The operator of any meat market, sausage kitchen, or similar establishment, who adds any sulphite to his meat products, places himself liable to court action as provided for by the law. Sodium benzoate may be used as a preservative only if the product to which it is added is properly labeled by means of a stamp, sticker or label, as follows- "Contains not to exceed 1/10 of 1% Sodium Benzoate", or similar informative statement. If sodium benzoate is added to any meat product, which is sold without proper labeling, it is a direct violation of Act 142 of 1936 and places the vendor liable to court action as provided for by the law. Any meat product to which has been added, as a preservative, sodium benzoate, ceases to become a "fresh meat" product and is considered a processed food,subject to registration, under the terms of Section 17, Act 142 of 1936. In applying for registration the application should be accompanied by a copy of the sticker, stamp or label which is used to mark the product as "contains added Sodium Benzoate not to exceed 1/10 of 1%".

Regulations for slaughtering, butchers, butcher shops, markets, according to the Louisiana State Sanitary Code are as follows: (1) The business of slaughterining cattle, sheep,swine, pigs or calves for use as food shall be conducted only after obtaining a permit from the Louisiana State Department of Health, (2) slaughtering must be in building made of material which can be maintained in sanitary condition, and of the following dimensions -(a) not less than 12 feet square inside,(b.)12 feet high from floor to ceiling.

The building must be disconnected from any store room for hides by at least 50 feet, and not less than 125 feet from any house, residence, water closet, hog pen, or anything that

might pollute the ground or atmosphere.
(3) Floors must be sound and water tight, properly drained and connected to sewer. If sewer is not available, provision must be made to carry all blood, offal, refuse, etc. in water tight containers to a place at least 125 feet from slaughter, where the refuse can be burned or deposited without creating a public nusiance or hazard.
(4) The walls of slaughter houses, meat dressing and cooling rooms must be tight and smooth for at least six feet above the floor with exception of opening of door and windows which must be provided with glass or shutters and properly screened with 18 mesh wire, as protection against dust and insects.
(5) All screen doors must open outside and all other doors must be swinging type to open in or out.
(6) Hot and cold water must be provided in abundance and be convenient to the building. If ground water is used, the well must be situated not less than 125 feet from any source that might contaminate or pollute it. Running water is desirable where possible. Ample water, soap and towels for cleaning hands and instruments must be in the room.
(7) All woodwork except floor must be painted, whitewashed, enameled or calcimined and kept white.
(8) The floors and all instruments, hooks, etc. that touch the meat must be cleaned daily with hot water and soap or lye.
(9) All edible offals such as livers, hearts, tongues, etc. must be hung on racks immediately after slaughter and removal from carcasses and shall remain there until inspected by proper health official. All such organs must be marked in order to be able to identify them with carcasses from which they were removed. They shall not be removed from rack except by permission of inspector.
(10) At least 1" of the diaphragm of all carcasses of all slaughtered animals must be left in the animal until meat inspector has made his examination and approved same. The lining of the chest and abdominal cavity (parietal pleura and peritoneum) must not be removed from carcasses until examined by meat inspector.
(11) No person must be allowed to urinate, defecate, or commit any nusiance whatsoever in the slaughter house or abattoir or within 125 feet radius of it.
(12) All slaughtering, dressing and removal of offal and refuse must be completed by 5:00 P.M. except upon special permission of inspection officer.
(13) Floors, walls, etc. must be flushed, washed and thoroughly cleaned every day. Tubs, buckets or other receptacles in which waste is deposited must be cleaned and disinfected as directed by the inspector.
(14) All the premises of slaughter houses, or where animals are prepared for food, must be maintained in sanitary condition at all times.
(15) Dogs must not be permitted in slaughter houses on account of danger of spreading echinococcus and other parasites.
(16) All animals condemned and rejected on inspection will remain the property of the butcher. All such animals must be immediately delivered by the owner to some responsible rendering establishment or be immediately rendered unfit for food and so disposed of as to commit no public health hazard. The condemnation of all meat or meat products wherever they may be must at the discretion of the inspector be saturated with some chemical to prevent their use as food.
(17) The emptying of the contents of the digestive organs of slaughtered animals on the floor of the slaughter house must be prohibited.
(18) The feeding of hogs or other animals on the refuse from slaughter houses is not permitted on the premises, nor must such refuse be used as food for other animals at any other time except when cooked to prevent the spread of diseases, especially trichinosis, tape worm, echinococcus.
(19) All meats, livers, tongues, etc., brought into the state must be thoroughly examined by the meat inspector. Such meats must bear the stamp of approval of the United States Government authorities.
(20) All places used for slaughtering or keeping livestock intended for food must have adequate pumps and water pipes and an abundant supply of cold and warm water and adequate means for disposal of wastes.
(21) Any place where meat is sold must be thoroughly cleaned every twenty-four hours and kept in sanitary condition.
(22) All meats or meat products when in transport, or stored, or displayed for sale, must be cleanly wrapped or covered and enclosed as protection against dust and insects.
(23) All meat used for sale must have the stamp of approval of the United States Bureau of Animal Industry or Louisiana State Department of Health.
(24) All meat markets must comply with all general sanitary measures. Specific regulations are as follows:

- (a) The market should not be less than 10 feet by 15 feet in superficial area.
- (b) It must be well ventilated and the floors must be of flagging or cement pavement, or other material impervious to water, which can be readily maintained in a sanitary condition at all times.
- (c) The use of sawdust, sand or other absorbent material on the floors of markets and

butcher shops is prohibited.

(d) Markets are required to be washed and cleaned each day and kept in the highest state of cleanliness.

(e) The market must not be used for any domestic purposes.

(f) Scraps of meat, offal, bones and other organic matter must not be exposed to the atmosphere of the room, but must be kept in a closed receptacle, which must be emptied at least once daily.

(g) Meat for sale must not be kept exposed to air except in such quantities as are needed for immediate use, but must be kept in refrigerators or ice chests.

(h) Every market must have a refrigerator or ice box in use of suitable size which must be scoured and aired thoroughly at least once weekly and kept clean.

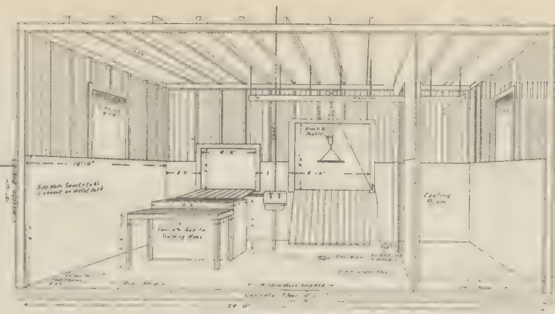
(i) All meat which becomes tainted in any manner must be removed from the premises at once.

(j) Chopping blocks must be scraped daily and counters thoroughly scoured. All knives, saws, meat grinders and choppers and other implements must be scalded and washed thoroughly daily.

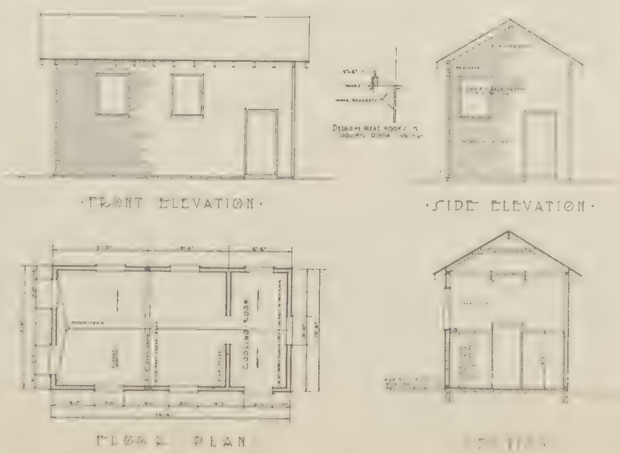
(25) No public or private market shall be established except by the consent of the state, parochial or municipal department of health, but the permit granted in any case may be revoked by the State Department at any time for infraction of the State Sanitary Code.

(26) All regulations for any food handling establishment pertaining to health certificates, screening, ventilation, floors, spitting, insects, toilets, lavatories, towels, soap, etc. also apply to meat markets.

References: (1) Sanitary Inspector's Handbook - Clay
(2) Preventive Medicine and Hygiene - Rosenau
(3) Louisiana Sanitary Code



INTERIOR VIEW OF RURAL
SLAUGHTER HOUSE



· SLAUGHTER HOUSE ·

SLAUGHTER HOUSES

These plans and drawings are intended as a guide in the construction of a sanitary slaughter house, in rural districts and small towns. In order to meet sanitary requirements, they may be enlarged or reduced to meet your present requirements. In selecting a location and constructing a slaughter house, you should keep in mind the following regulations:

(1) The ground surroundings shall be well drained and have no stagnant water within 300 feet of intended location of building.

(2) [illegible] and the probability of [illegible] building.

(3) Availability of water in sufficient quantity for all purposes, that is for washing floors, walls and meats during slaughtering.

(4) The floors, walls, ceilings, partitions, posts, doors and other parts of all structure shall be of such materials, construction and finish as will make them susceptible to being readily and thoroughly cleaned. The floors shall be kept water-tight.

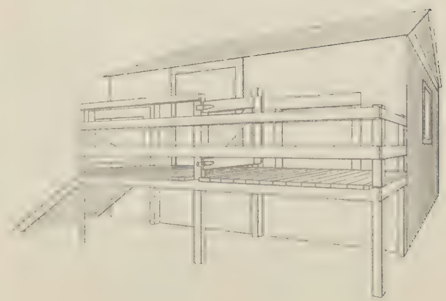
(5) The building should be equipped with proper racks, receptacles or other devices for holding heads, tongues and other parts to be used for food.

(6) [illegible]ipment and utensils shall be of such materials and construction as will [illegible] them susceptible to being readily and thoroughly cleaned.

(7) There shall be properly located facilities for disinfecting and cleansing utensils and hands of all persons handling meats.

(8) Inside of building shall be painted white.

(9) There shall be provided running hot and cold water whenever possible. If impossible to provide running hot and cold water, some means of having hot water should be provided.



Seafood Control

Seafood is one of the most quickly perishable of foods. It is therefore necessary that the inspector be intimately acquainted with the signs of freshness or staleness and the methods by which various kinds of seafood may be examined.

FISH: Fish are in best condition prior to spawning. The spawn is produced at the expense of flesh and tissue. After spawning, fish appear ill fed, and the flesh is soft and flabby and will not keep. Fresh fish appear (1) bright in appearance as if still alive, (2) eyes are bright and full, (3) gills are bright red in color, (4) flesh is firm to the touch, (5) abdomen is clean and free from offensive odor, (6) blood is fresh red in color and of normal consistency, (7) when split, the flesh adheres to the bones, (8) the back bone is a pearly gray color. Stale fish appear (1) dull, lifeless, (2) eyes are sunken, (3) gills are [illegible] color, (4) flesh is soft and limp, (5) abdomen is discolored and the odor offensive, (6) blood is dark, thin in consistency, and may be offensive, (7) when split, the flesh leaves the bones easily, (8) the back bone has a pink discoloration

Fresh shrimp when handled, slip crisply over one another, i.e., handle dryly. The odor of ammonia is indicative of decomposition. Crabs and lobsters should be alive when sold.

Shell Fish: Oysters, clams and mussels when fresh, should be firmly closed or should close immediately when touched. If tapped together, they should sound like hard pebbles. A "gaper" oyster is a spoiled one. A good deal of shell fish is eaten raw or only partially cooked. They are rarely completely sterilized by boiling, and if derived from layings polluted by sewage, there is a real danger of their being the means of conveying water-borne diseases such as typhoid fever, dysenteries, or other gastro-intestinal disturbances.

The sanitary requirements for shellfish as designated by the Louisiana Sanitary Code are more or less adequate, but the requirements recommended by the United States Public Health Service are more detailed and up-to-date and include practically all items declared in the former code. The latter is reproduced below.

UNITED STATES PUBLIC HEALTH SERVICE MINIMUM REQUIREMENTS FOR ENDORSEMENT OF STATE SHELLFISH CONTROL MEASURES AND CERTIFICATIONS FOR SHIPPERS IN INTERSTATE COMMERCE. (Revised Oct., 1937).

I. GENERAL

1. Shellfish Defined. For the purpose of these requirements the term "shellfish" is hereby declared to mean and include oysters, mussels and all varieties of clams.
2. Classification of Waters.
   a. Approved Areas. Areas which may be approved for the taking of shellfish for market purposes without serious question. These areas are protected against human fecal contamination by distance from sources of such pollution, by dilution and by the time afforded for natural purification so that there is no discoverable likelihood of dangerous contamination.
   b. Moderately Polluted--Restricted Areas. Areas which are intermediate between approved and grossly polluted areas as regards exposure to and protection against fecal pollution. A decision as to whether any given area in this class may be used for the taking of shellfish, and if so, under what conditions, should be based, in each instance, upon a careful and thorough study of the area which would take into account all factors which might affect the decision, namely; the findings of sanitary survey and on bacteriological examinations of the water. Added safeguards to be considered in the taking of shellfish from this class of areas are: (1) Relaying in approved areas, (2) biological cleansing of the shellfish by controlled treatment in chlorinated water, and (3) a seasonal restriction which takes cognizance of the relative protection afforded by hibernation of the oyster.
   c. Grossly Polluted--Restricted Areas. Areas from which the taking of shellfish for market purposes is not permitted. This class includes: (1) Areas obviously subject to gross polution by the direct discharge of sewage, (2) areas demonstrably exposed more or less continuously to even slight direct contamination with human fecal discharges from nearby sources, (3) areas which, though usually of good quality, are exposed to occasional direct and immediate contamination with human discharges.
3. Holders of Certificates. Certificates of compliance with the state requirements governing the sanitary control of the shellfish industry shall be issued to the following:
   a. Interstate shippers of shell stock only. The certificate shall plainly show that it covers only the shipment of shell stock.

b. All "buy" boats upon which the operator maintains a business of buying and selling shellfish as well as transporting shellfish. These shall be considered as shell stock shippers.
c. All interstate shippers operating plants for the shucking and packing of shellfish. The certificate shall indicate that it covers shucking and packing.
d. All interstate shippers operating plants for the repacking of shucked shellfish. The certificate shall indicate that it covers repacking.
e. All persons operating a shucking and/or packing plant selling its products to an interstate shipper as defined in (c) and (d). The certificate in this case to be as in (c).

4. Records. Every person, firm or corporation who conducts any wholesale business of buying, selling or shipping shellfish shall keep an accurate daily record which shall show the names and addresses of all persons from whom lots are received, the location of the source of each lot, and the names and addresses of all persons to whom lots are sold or shipped. Such records shall be kept on file for 60 days and shall be open to inspection at any time during business hours by any duly authorized representative of the state agency having jurisdiction over shellfish sanitation.

II. GROWING AND GATHERING.

1. Growing Areas. No shellfish shall be taken from any water for market purposes except from such grounds or growing areas as have been approved by the state agency having jurisdiction over shellfish sanitation. Areas which may be approved shall be so protected against human fecal contamination by distance from sources of such pollution, by dilution and by time afforded for natural purification, that there is no discoverable likelihood of dangerous contamination. Provided: That permission may be granted by the state agency having jurisdiction over shellfish for the removal of shellfish from moderately polluted areas for conditioning and purification prior to marketing and to market them after relaying in a large body of clean water of subjecting them to some approved method of treatment but only under conditions which shall include the following:
   a. That such permission be granted only to responsible individuals under special permit, such special permit to be revoked in case of violations of the conditions thereof. (It may be desirable that such individuals be bonded to be forfeited in case of any violation of the conditions of the permit.)
   b. That such permits shall in no instance be issued for removal of market stock from grossly polluted areas during the open market season.
   c. That the removal and relaying shall be under the immediate supervision of the state agency having jurisdiction over shellfish sanitation.
   d. That shellfish relaid from moderately polluted waters in a designated area of approved waters shall remain down for a period of not less than seven days when the water in which relaid has a temperature above 50° F. When the water temperature is below 50°F. shellfish shall not be relaid.
2. Water Storage or Floating. The water storage, cleansing, bedding, or conditioning of shellfish shall not be permitted or practiced in:
   a. Artificial bodies of water unless the entering water has a bacteriological quality at all times at least equal to the United States Treasury Department Standards for drinking water, or,
   b. Natural bodies of water which are subject to either constant or intermittent pollution as disclosed by the sanitary survey nor any water in such proximity to dwellings, industrial plants, boats, or docks that their cleanliness can be protected only by the strict observance of sanitary regulations by all persons in the vicinity. (Attention is also directed to the requirements of the U. S. Food and Drug Administration concerning the salinity of water needed for storage, floating, bedding or conditioning.)
3. Boats. All boats used in the taking and handling of shellfish shall be kept in such a state of cleanliness and repair that shellfish hauled or stored thereon shall not be subject to contamination by bilge water, through leakage of polluted water, or by other means. Decks, holds, or bins used for storage on boats shall not be washed with polluted water. Reasonable precautions shall be observed by fishermen while boats are in waters over shellfish grounds to prevent the pollution of such grounds through the discharge of human wastes.
4. Storage. Shellfish held in wet or dry storage must be so kept at all times that they will not become contaminated.

III. SHUCKING AND PACKING PLANTS*

1. Construction.
   a. Lighting and ventilation shall be adequate in all parts of the building used.
   b. Space used for washing and packing shall be effectively separated from space used for shucking. Rooms used for the above purposes shall be so constructed throughout as to permit easy and thorough cleaning and afford adequate protection against flies.

*Only clean oysters which are alive & have tight shells shall be used for shucking - La. Sanitary Code.

c. Floors shall be constructed that they may be easily and thoroughly cleaned, and that drainage of all water therefrom shall be complete and rapid.
d. Storage bins or storage rooms for shell stock shall be so constructed as to permit easy and thorough cleaning and drainage.
e. Shucking benches shall be of an approved sanitary type. Such benches, and walls immediately adjacent to the benches to a height of two feet above the benches, shall be of smooth material and so constructed as to be easily and thoroughly cleaned.
f. Sanitary toilets of a type approved by the state health authority shall be provided. Toilets shall not open directly upon rooms used for shucking or packing. If a privy is provided it shall be of an approved sanitary type properly located.
g. Refrigeration rooms or ice boxes for the retention of shellfish shall be so constructed as to permit easy and thorough cleaning. It is recommended that the floor of the refrigeration room be constructed of concrete and that the ice box have an impervious lining.

2. Equipment.
a. Water. The plant shall be provided with an abundant supply of water, preferably under pressure, from a source approved by the state health authority. No cross connections with unapproved water supplies shall be permitted.
b. Hot water in sufficient amount for all purposes shall be available when the plant is in operation. A minimum quantity of two gallons per shucker is considered necessary.
c. Lavatories with running water, shall be provided, together with soap and individual towels.
d. Utensils. Shucking pails, measures, skimmers, colanders, tanks, tubs and paddles shall be made of a non-corrosive, non-rusting smooth, impervious material, and constructed in such manner as to eliminate grooves, seams and cracks where food particles and slime will collect. All seams and joints shall be well filled with solder and dressed to a smooth surface. The handles of opening knives shall be so constructed as not to contain cracks and crevices which would retain food particles and slime.
e. Shipping containers. The use of shipping containers other than metal for shucked stock shall not be permitted except non-returnable, non-reuseable shipping containers of waxed paper which may be used under the following conditions: Containers must be purchased in hermetically sealed packages and kept therein in a clean dry place until used. All containers must be stored and handled so that the inside surface thereof will not become contaminated.
f. Returnable containers shall have straight walls and tight fitting covers. They shall be made of a non-rusting, smooth metal and constructed in such manner as to eliminate grooves, from which particles of food and slime cannot be readily removed by washing, and shall contain no seams and cracks. All seams and joints shall be well filled with solder dressed to a smooth surface. Use of returnable containers which do not meet the above requirements is not approved.

3. Operation.
a. Communicable diseases. No person who has any communicable disease, or any open lesion on the hands, arms or face, shall be employed or retained in any shucking or packing plant. (The Louisiana Sanitary Code requires no certificates of medical examinations from those engaged inshucking oysters that are to be steamed for canning).
b. General cleanliness. During the operating season the plant shall be used for no other purpose other than the handling of shellfish or other seafoods. Material foreign to this particular business shall not be stored within the operating part of the plant. All abandoned equipment shall be removed from the plant and the floors in every way kept clear for thorough cleansing. The unoccupied portion of the storage bins, the shucking benches, and all the floors shall be swept and flushed with water of an approved quality at least once every day, at the completion of the day's run, until they are thoroughly clean. The use of polluted water for flushing or cleansing purposes shall not be permitted. A safeguard recommended is that of following the cleansing with a thorough flushing with scalding water or a solution of calcium or sodium hypochlorite of approved strength. This treatment is particularly advisable in the case of shucking benches. Refrigeration rooms or ice boxes shall be washed out and scalded once a week, or more often if necessary. Once a week the cleansing shall include the washing of walls.
c. Personal cleanliness. All employees shall wash their hands thoroughly with running water and soap on beginning work and after each visit to the toilet. Signs to this effect shall be posted in conspicuous places in the plant by the operator.
d. Sterilization. All utensils and tools, such as opening knives, shucking pails, measures, skimmers, colanders, tanks, tubs, and paddles, which come in contact with the shellfish, shall be thoroughly scoured until clean, using soap or an

alkali cleanser and then sterilized either (1) by steam in a steam chamber or box, by exposure to 170°F. or more for at least 15 minutes or to 200°F. for at least five minutes or (2) by immersing in hot water at a temperature of 170°F. or more for at least two minutes or (3) by exposure to a steam jet for 1 minute. In addition to these precautions the immersion of clean utensils in a strong chlorine solution, which will still contain at least 50 parts per million of free chlorine after the utensils have been in the solution two minutes, will be helpful in maintaining sanitary conditions. Such sterilization may be carried out before beginning work, or at the close of the day if the articles are stored over night so as not to become contaminated. Returnable shipping cans must be cleaned and sterilized by steam at the shipping plant prior to refilling.

e. Nonreturnable containers shall be rinsed with water from an approved source before filling.

f. Floor shucking shall not be permitted. Floors used by shuckers shall not be used for the storage of shellfish or for the retention of shucking pails. Where shellfish are stored in the shucking room, adequate protection shall be provided for the storage space to prevent possible contamination from wash water wastes, and from the feet of the employees. Shucking pails shall be so placed as to exclude the drippings from shells and from the hands of the shuckers.

g. The "nesting" of empty pails shall not be permitted during the operation season. When not in use pails shall be inverted on racks or benches provided for this purpose.

h. Refrigeration. The cooling of shucked shellfish to a temperature of 50°F. or less shall be effected within two hours after the shellfish are shucked. For the refrigeration of shucked stock outside containers shall be provided for ice, and no ice or other foreign substances shall be allowed in contact with the shellfish after processing has been completed. (Louisiana Sanitary Code requires refrigeration at 45°F. or less).

i. Washing shucked stock. Shucked shellfish, when washed, shall be thoroughly washed with cold water of an assured purity. (Attention is directed to the requirements of the U.S.Food and Drug Administration relative to washing of shucked stock).

j. Waste disposal. Shells, washings and other wastes shall be disposed of in such manner as not to cause a nuisance.

k. The hands of all persons touching shellfish after they have been shucked shall be scrupulously clean.

4. Shipping.

a. Shucked stock shall be stored and shipped under such temperature conditions as will prevent spoilage. Outside containers shall be provided for ice, and no ice or other foreign substance shall be allowed to come in contact with the shellfish during shipment or storage. (It is recommended that shucked stock be kept at a temperature of 50°F., or below, from the time it leaves the shipper until it reaches the consumer, but that it be not allowed to freeze except where approved freezing processes are employed).

b. Shucked oysters and clams shall be packed and shipped in approved containers sealed in such manner that tampering is easily discernible, and marked with packer's certificate number impressed or embossed on the side of such container and preceded by the state abbreviation. Shipments shall be so tagged or labeled as to show the name and address of the consignee, the name and address of the shipper, the name of the state or origin, and the certificate number of the shipper.

c. Use of containers bearing the certificate number of another shipper shall not be permitted.

IV. SHELL STOCK PLANTS

1. Construction.

a. Lighting and ventilation shall be adequate in all parts of the building used.

b. Floors shall be so constructed that they may be easily and thoroughly cleaned, and drainage of all water therefrom shall be complete and rapid.

c. Storage bins or storage rooms for shell stock shall be so constructed as to permit easy and thorough cleaning and drainage.

d. Sanitary toilets of a type approved by the state health authority shall be provided. Toilets shall not open directly upon rooms used for storage or packing of shell stock. If a privy is provided it shall be of an approved sanitary type properly located.

e. Refrigeration rooms or ice boxes for the retention of shellfish shall be so constructed as to permit easy and thorough cleaning.

2. Equipment.

a. Water. The plant shall be provided with an abundant supply of water, preferably under pressure, from a source approved by the state health authority. No cross connections with unapproved water supplies shall be permitted.

b. Lavatories with running water shall be provided, together with soap and individual towels.

3. Operation.

a. General cleanliness. During the operating season the plant shall be used for no other purpose than the handling of shellfish or other sea foods. Material foreign to this particular business shall not be stored within the operating part of the plant. All abandoned equipment shall be removed from the plant and the floors in every way kept clear for thorough cleansing. The unoccupied portion of storage bins and all floors shall be swept and flushed with water of an approved quality at least once every day, at the completion of the day's run, until they are thoroughly clean. The use of polluted water for flushing or cleaning purposes shall not be permitted. A safeguard recommended is that of following the cleansing with a thorough flushing with a solution of calcium or sodium hypochlorite of approved strength. Refrigeration rooms or ice boxes shall be washed out once each week, or oftener if necessary.

b. Personal cleanliness. All employees shall wash their hands thoroughly with running water and soap on beginning work and after each visit to the toilet. Signs to this effect shall be posted in conspicuous places in the plant by the operator.

c. Waste disposal. Shells, washings and other wastes shall be disposed of in such manner as not to cause a nuisance.

4. Shipping.

a. Packing. Shell oysters, clams and mussels shall be packed in clean barrels or sacks and handled and shipped under such temperature conditions as will keep them alive.

b. Identification of shellfish found on the market. In order that information may be available to inspectors and others with reference to the origin of shell stock from all areas, containers holding shell stock shall be identified with a uniform tag or label. The information upon such tag or label shall include the name and address of the shipper, name and address of consignee, certificate number issued by the supervising authority in the state of origin, together with the state abbreviation, date of dredging, date of shipment or of reshipment, and name of the local waters from which the shellfish were taken. The stub of the tag shall not be removed from any package of shell stock until all of the contents of such package have been removed. The form and size of the tag shall be substantially as shown. Tags shall be of substantial stock, reasonably water-proof, similar or equivalent to Dennison "all rope stock" or of "P" stock and at least as large as Dennison No. 6 Tag - 2-5/8" x 5-1/4" and manilla color.

c. Bulk shipments by truck or car. Shipments in bulk shall not be made by truck or car except where the shipment is from only one consignor to only one consignee, and accompanied by the uniform shipping tag before specified.

d. Bulk shipment in tongers' or dredgers' boats. Bulk shipments by boat may be made in cases where the tongers or dredgers obtain the shellfish directly from growing areas and sell them to various consumers direct.

e. Bulk shipments in "buy" boats. (1) If intended for the shell trade, shellfish must be contained in packages suitably labeled to permit identification as outlined in IV-4-b. (2) If intended for processing in shucking houses, records must be kept by the boat operator in a book provided for such purposes only, showing sources and quantity of shellfish, date and local waters where the shellfish were taken, license or certificate number of person or persons from whom shellfish were obtained, and person or persons to whom sold.

Shrimp: The requirements for shrimp sanitation, according to the Louisiana Sanitary Code are practically the same as listed above for shellfish except that: (1) It shall not be necessary for persons employed in seining or fishing for shrimp or engaged in shelling raw shrimp for canning, to have certificates of medical examination. (2) It shall be lawful for shrimp to come in contact with ice. (3) Shrimp need not be packed in closed containers.

For Louisiana regulations on crabmeat and shrimp, see Sanitary Code.

Food Sampling

(From "Inspectors Manual - issued by the Food and Drugs Administration of Federal Security Agency - 1940")

Below is outlined the size of samples that should be collected of various types of food in order to represent an "adequate sample" for testing.

A. Beverages and Beverage Material: (1) Fruit Flavors - (a) expensive, highly concentrated flavors, not less than 2 fluid ounces, (b) if produce costs $2.50 or less per pint, collect 2 pints. (2) Dried Products, 2 one-pound samples. (3) Fruit juice, beverages, syrups, etc. - 2 quarts in original container if practical. (4) Alcoholic Beverages - [illegible] pints, 2 quarts, or 1 gallon. (5) Flavoring Extracts - vanilla, lemon extract, etc.- not less than 1 pint.

B. Cereal Products:(1) Alimentary Pastes. (a) Egg noodles - collect enough retail packages (not less than three) to make 5 pounds. From bulk packages, composite a 5 pound sample from the square root of the packages in the lot. (2) Flour - take a sample from the square root of the number of bags in lot, but not less than 10. (3) Corn Meal and Buckwheat Flour- same as flour.

C. Chocolate Products:(1) From bulk, collect 1 pound. (2) Packages less than 2 pounds, collect whole package. (3) No sample should be less than 1 pound.

D. Coffee: (1) If there are less than 10 cases in lot - obtain 1 package from each of [illegible] cases. (2) If there are more than 10 cases in lot - obtain 1 package from each of 6 cases.

E. Dairy Products:(1) Butter - take three regular butter trayfuls from each tub or cube samples. Print Butter - if 5 or less cases are available, sample all. Up to 25 cases - take samples from case equal to square root of number of cases. Take not less than four prints from sample case.

(2) Cheese. (a) Cheddar -

number of cheeses	cores	number of samples - subdivisions
10 or less	3	1
11 - 30	6	2
31 - 50	9	3
51 - 75	12	4
76 - 100	15	5

(b) Swiss - take sample from each cheese as follows: 3 cores from the flat surface of each wheel, 1 from center, 1 half way between center and outer edge, and 1 in the opposite sector near the outer edge. (3) Dry Milk - sample the square root of the number of containers in the lot.

F. Eggs: (1) Shell Eggs - 25 or less cases - sample one side of 5 different cases. Over 25 cases - one side of cases equal to square root of the number of cases in lot. (2) Frozen Eggs - if first 10 to 20 cans are good, take for granted the lot is good. (3) Sample the square root of the number of packages in lot, taking 1/2 pound from sample packages.

G. Fish, Clams, Oysters, Salmon, Sardines, Mackerel, Tuna, Shrimp, Herring Roe: (1) Canned- take one can from each case, unless there are fewer than 48.

Number of Cases	Number of cans for sample
Below 200 - - - - - - - - - - - - -	48
200 - 1,000 - - - - - - - - - - - -	96
1,000 - 2,000 - - - - - - - - - - -	192
2,000 - 5,000 - - - - - - - - - - -	288
5,000 - 10,000 - - - - - - - - -	576
10,000 - or more - - - - - - - -	960

(2) Frozen - if units consist of 10 or 15 pound boxes - less than 100 boxes, sample 6 units; 100-300 boxes, sample 10 units; 300-500 boxes, sample 15 units; 500-1,000 boxes, sample 20 units; over 1,000 boxes, sample 30 units.

H. Fruits and Fruit Products: (1) Small, fresh fruits - 1 quart from each of 4 crates in lots of 16 crates or less, 1 quart from the square root of number of crates in lot when these are more than 16 crates in lot. (2) Jams and jellies, not less than 4 pounds. If jars are smaller than 1 pound, sample 4 cases; if jars are 1 pound or 2 pounds, collect one from each of 4 cases. (3) Vinegar - bottles - take enough to total 2 gallons;barrels- sample 3, 1 gallon from each.

I. Grains and Feeds:Cottonseed meal, feed, calcium phosphate, and other phosphates. Less than 25 sacks - sample all. More than 25 sacks - sample square root of number of sacks, but not less than 25 sacks.

J. Meats and Meat Products: (1) Poultry and Rabbit - sample every barrel, where there are 3 or less barrels. Sample square root of barrels where there are more than [illegible] barrels, but not less than 3 barrels should be sampled. (2) Ground Fresh Meats - (hamburger, pork sausage either bulk or links, sausage meats, etc.) at least 1 pound. (3) Smoked Sausage- one ring or length. (4) Prepared Sausage - (wieners, frankfurters, bologne, and other similar types) - one ring if put in rings - at least 2 pounds, if put up in lengths, cans, or other units of two pounds or more.

K. Nuts and Nut Products: (1) Nuts in shell - at least 600 nuts. (2) Shelled nuts - sample the square root of the number of containers in the lot, but not more than 15 or less than 5. Subsample from each container should be about 1 pound.

L. Olive Oil and Other Foods: Sample all sizes - 3 original packages if they are smaller than 1/2 gallon, 2 original packages if they are 1/2 gallon, 1 original package if they are 1 gallon. For bulk - if there are 3 or less containers take 4 fluid ounces from each, if there are 4 to 16 containers take 4 fluid ounces from four, if there are 16 or more containers sample the square root of the number of containers.

M. Confectionary: (1) Syrup and Molasses.

Size of Lot	Number of Subsamples: Quart size or smaller	Larger
Up to 50 cases	12	6
More than 50 cases	24	12

N. Shellfish: (1) Fresh Oysters - for pint containers in multiples of 8, i.e., one out of every 8 containers; 1 gallon is the minimum size of sample. (2) Shrimp - cooked, peeled, headless - collect four subsamples of 8 ounces each from different containers in each barrel. Each subsample includes pieces from top, bottom, and middle of the can. (3) Canned crab meat - if there is more than 1 barrel and less than 10, submit 2 subsamples from each barrel. If there are more than 10 barrels, submit 1 subsample from each barrel. Each subsample is at least 2 ounces.

O. Spices and Condiments: (1) Mayonnaise, mustard and salad dressing - at least 2 quarts. Collect 12 jars if there are 10 cases or more in lot - sample proportionally if there are less than 10 cases.

P. Vegetables and Vegetable Products: (1) Fresh vegetable - cabbage, cauliflower, peppers, squash, cucumbers, egg plants, etc. Collect 10 specimens from the lot for larger vegetables. Collect 4 pounds of small vegetables from lot. (2) Celery - 14 stalks from lot, at least one from each crate. (3) Dried beans - at least 4 quarts - sample at least 10% of bags in a lot over 100 bags. Lots less than 100 bags, sample 10 bags.

(4) Olives

		Quart size containers or smaller	1/2 or 1 gallon
(a) Packaged	up to 50 cases	12	6
	more than 50 cases	24	12

(b) Bulk - sample the square root of the number of containers in lot, but not more than 24. Each subsample is 1 quart.

(5) Tomato Catsup, paste, puree, pulp, juice. (a) Containers smaller than 1 gallon size - sample the square root of the number cases in lot. If there are less than 120 cases, take one from each 10 cases. If containers are 4-3/4 ounce size, collect at least 20 cans. (b) 1 gallon containers - sample should be 1/2 size stated above. (c) Containers larger than 1 gallon - collect subsamples of 1 pint each taken from 1/2 the square root of the number of containers in the lot. (add 1/4 to 1/2 ounces of 40% formaldehyde solution to each pint jar).

Q. Canned Foods: (Those not before mentioned).

	Minimum number of subsamples
No. 3 and smaller cans	
Small lots	24 cans
Up to 1,000 cases	48 cans, 1 from each case
1,001 to 3,600 cases	72 cans, 1 from each case
Cans larger than No. 3	
Up to 600 cases	24 cans, 1 from each case
601 to 900	30 cans, 1 from each case
901 to 1,300	36 cans, 1 from each case

Non-Perishable Foods:

Use sterile fruit jars for collecting sample. The implement used to transfer food to jar should be sterile.

Perishable Foods:

Collections should be by sterile methods and provisions for icing should be at hand.

See TABLE OF SQUARE ROOTS AND APPROXIMATE WEIGHT AND MEASURE EQUIVALENTS, page 234.

TABLE OF SQUARE ROOTS

4 - 2	484 - 22	1,764 - 42	3,844 - 62
16 - 4	576 - 24	1,936 - 44	4,906 - 64
36 - 6	676 - 26	2,116 - 46	4,356 - 66
64 - 8	784 - 28	2,304 - 48	4,624 - 68
100 - 10	900 - 30	2,500 - 50	4,900 - 70
144 - 12	1,024 - 32	2,704 - 52	5,184 - 72
196 - 14	1,156 - 34	2,916 - 54	5,476 - 74
256 - 16	1,296 - 36	3,136 - 56	5,776 - 76
324 - 18	1,444 - 38	3,364 - 58	6,084 - 78
400 - 20	1,600 - 40	3,600 - 60	6,400 - 80

APPROXIMATE WEIGHT AND MEASURE EQUIVALENTS

Grains	Grams	Grams	Grains	Avoirdupois pounds	Kilograms	Avoirdupois ounces	Grams
15.43	1.0	1	15.432	1	0.454	0.035	1
5	.324	2	30.86	2	0.907	.071	2
2½	.162	3	46.29	3	1.361	.106	3
1	.065	4	61.72	4	1.814	.141	4
7/8	.0567	5	77.16	5	2.268	.176	5
3/4	.0486	6	92.59	6	2.722	.212	6
1/2	.0324	7	108.0	7	3.175	.247	7
3/8	.0243	8	123.5	8	3.629	.282	8
1/4	.0162	9	138.9	9	4.082	.317	9
1/8	.0081	10	154.3	2.205	1	1	28.350
1/10	.0066	11	169.8	4.409	2	2	56.699
1/16	.0040	12	185.2	6.614	3	3	85.049
1/20	.0032	13	200.6	8.818	4	4	113.398
1/25	.0026	14	216.1	11.023	5	5	141.748
1/30	.0022	15	231.5	13.228	6	6	170.097
1/40	.0016	16	246.9	15.432	7	7	198.447
1/50	.0013	17	262.4	17.637	8	8	226.796
1/60	.0011	18	277.8	19.842	9	9	255.146
1/64	.0010	19	293.2				
1/100	.0006	20	308.6				
1/150	.00044						

Colors Used In Foods, Drugs and Cosmetics

(Food, Drug, and Cosmetic Act Trade Correspondence - June 1940)

A. Classification: (1) Mineral colors - Prussian blue, Ultramarine blue, Chromate of lead. (2) Coal tar colors - (a) Class 1 - Nitro, nitroso, and azo colors (picric acid, naphthol yellow, ponceau, bordeaux, and congo red.) (b) Class II - Indogenide and imidoquinone colors (methylene blue, safranin, indigo carmine). (c) Class III - Amido derivatives (fuchsin, rosanilin, auramin). (d) Class IV - Nonamide diphenyl methane, oxyketone and most of the natural organic coloring waters (eosin, aurin, alizarin). (3) Vegetable and animal colors - caramel, cochineal, cudbear, archil, litmus, azolitmus, logwood, brazil wood, barwood, catechu, spanish saffron, quercitron, sumac, annatto, turmeric, persian berry extract, fustic extract, weld extract, buckthorn, kalama, poke berry, carthamin (safflower).

B. Certification and Listing of Colors by Federal Government - Only coal tar colors must be certified. Each individual batch of coal tar colors must be certified. Vegetable, animal or mineral colors do not require certification.
If, after adequate investigation, the color is found to comply with the regulations, the Food and Drug Administration of the Federal Government issues a certificate covering the batch in question. This certificate bears the lot number assigned to the batch and shows the pure dye content found in the batch. A request for listing of a color should be accompanied by: (1) Pharmacological data showing that the color is harmless and suitable for use for which it is proposed. (2) Chemical data showing methods for determination of the identity and purity of the color. (3) A five pound sample from a batch produced under practical manufacturing conditions. (4) An advance deposit of $500.00.

To obtain certification of an already listed color, only 1/4 pound sample should be submitted. A fee must be paid for certification of each batch.

I. Definition - Certified coal tar colors are those which upon investigation, are found to be harmless and suitable for use in accordance to the prescribed standards of purity. When a certain type of coal tar color is certified and listed in the coal tar regulations of the Federal Government, each succeeding batch of listed colors which are manufactured must be certified before it can legally be used in a food, drug, or cosmetic. Listing and certification are, therefore, an assurance of two things: (a) That the dye itself is harmless; (b) That the particular batch is free from harmful impurities.

II. Uses and Misuses of Certified Colors - Certified food colors may be used in some classes of food and not in others. (1) They cannot be used in milk. (2) Yellow coloring must not be used in macaroni, mayonnaise or bakery products to make them simulate the presence of eggs. (3) Certified colors may be used in butter, ice cream and cheese without labeling the product. (4) Candies may contain certified colors but must be labeled. (5) Not only must meat not be colored to make it look red, but such materials as paprika, tomatoes, etc. must not be used to make it look red even when the meat is labeled. (6) No coal tar color may be certified for use in any article to be applied to the area of the eye.

Batches of coal tar colors may be certified for use in three ways depending upon their nature. (1) In foods, drugs, and cosmetics. (2) In drugs and cosmetics (but not in food). (3) In drugs, and cosmetics applied externally only.

III. Naming of Colors and Labeling Requirements - According to the group in which colors are listed, they are prefixed-(1) FD&C (may be used in foods, drugs, and cosmetics). (2) D&C (may be used in drugs and cosmetcis). (3) Ext. D&C (may be used in drugs and cosmetics for external application only). The labeling requirements for coal tar colors are: (1) An accurate statement of the net contents of the package. (2) The name and place of business of manufacturer, packer or distributor. (3) In the case of mixtures for food use, the name of the color components and that of each diluent contained in the mixture. (4) The name of the color. (5) The lot number of the batch. (6) The pure dye content of the color. (7) In the case of a color certified only for a limited use, a statement setting forth this limitation. NOTE: Packages of coal tar colors shall be exempt from the label requirements relative to net content as follows: (1) Colors for food use containing less than 1/2 ounce avoirdupois or less than 1/2 fluid ounce or less than 6 units (if these units can be easily counted without opening the package), or if the label space is so limited that all required information cannot appear conspiciously. (2) Colors for drugs and cosmetics containing less than 1/4 ounce avoirdupois or less than 1/8 fluid ounce or less than 6 units (which can easily be counted without opening the package).

TYPICAL LABELS

Straight Colors (and repacks of straight colors) :

FD&C Red No. 1
____% pure dye
Lot. No.______
Net Weight:
1 lb. 4 ozs.
John Doe & Co.
Doeville, Tenn.

One pound D&C
Yellow No. 8
not less than
____% pure dye
Lot No. _____
Not for use in
coloring food
John Doe & Co.
Doeville,Tenn.

Ext. D&C blue No.1
not for use in coloring
food,or in coloring any
drug or cosmetic used
internally or on the lips
or any mucous membrane
_____% pure dye
Lot. No. ____________
Net weight: 8 ozs
John Doe & Co.
Doeville, Tenn.

Mixtures (and repacks of mixtures) :

One pound
Red rose shade
Mixture of
Certified coal
tar colors
___% pure dye,sugar
Starch
Lot No. _____
John Doe & Co.
Doeville, Tenn.

4 fl. ozs
Tom's liquid
Red color
contains not less
than ___% pure
dye from certi-
fied coal tar
colors, water,
glycerin, and
0.1% benzoate
of soda
John Doe & Co.
Doeville, Tenn.

Blank
Easter egg dyes
not for use in coloring
any food except shell eggs.
Net volume: 3 fl. ozs
contains __% pure dye from
certified colors,mineral
oil, and rosin
Lot No._____
John Doe & Co.
Doeville, Tenn.

NOTE: The phrase "net contents:___ounces" is ambiguous and should not be used as it may refer to liquid ounces or ounces avoirdupois.

Whenever an inspection is made of establishments manufacturing foods, drugs, or cosmetics, where colorings are added, all colors should be checked for the certification number as given by the Federal Food and Drug Administration, and for generally correct labeling of the color. If no certification number is given, then the color should be regarded with suspicion and placed under seizure pending receipt of the certification number.

Types of Violations Commonly Occurring In Relation to Various Types of Foods

A. Deleterious impurities are commonly found in: (1) Alcoholic beverages. (2) Mineral waters (pollution). (3) Maple sugar (lead). (4) Sardines (lead). (5) Fresh oysters (pollution). (6) Fruits and fruit products (arsenic,lead, fluorine). (7) Nuts and nut products (pollution). (8) Fresh vegetables (spray residue).

B. Preservatives and other substances proposed to be added are commonly found in: (1)Beverages and beverage materials (monochloracetic acid). (2) Chocolate drinks (monochloracetic acid). (3) Cream for butter making (formaldeyde,etc.). (4) Fresh or frozen fillets. (5) Frozen fruit and juices. (6) Ground fresh meats and meat products.

C. Dangerous and non-nutritive substances are commonly found in: (1) Candy;alcohol in candy.

D. Unpermitted and/or uncertified coal tar colors: (1) Meats or meat products.

E. Unfounded therapeutic claims in foods are commonly related to: (1) Alcoholic beverages, mineral waters, and crystals (such as Crazy Crystals).

F. Unreliable vitamin claims in foods are usually associated with: (1) Beverages including citrus and other fruit juices, and beverage bases. (2) Flour, bread, or cereals, bearing B claims. (3) Evaporated milk. (4) Fish oils (except shark, halibut and cod). (5) Vegetable oils fortified with vitamins A or D. (6) Tomato juice - vitamin C.

G. Special dietary foods (any question regarding this group of foods should be taken up direct with the Food and Drugs Section of the Louisiana State Department of Health). (1) For special use by reason of its vitamin properties in respect to: (a) vitamin A or its precursors, (b) vitamin B_1 (thiamin), (c) vitamin C (ascorbic acid), (d) vitamin D, (e) vitamin G (or B or Riboflavin), (f) other vitamin properties claimed. (2) For special use by reason of its mineral properties in respect to: (a) calcium, (b) phosphorus, (c) iron, (d) iodine. (3) For special use as a food for infants. (4) For special use in control of body weight or in dietary management of disease. (5) For special use by reason of the presence of non-nutritive constituents not utilized in normal metabolism(crude fibre, saccharin,etc.).(6) For special use by reason of the decrease or absence of allergenic properties.

H. Insanitary factory conditions may be found associated with: (1) Fruit juices and syrups, mineral waters and crystals. (2) Bakery products, and corn meal. (3) Confectionery,maple syrup, cane syrup, and molasses. (4) Butter, cheese, cream, evaporated milk, dried skim milk. (5) Crab meat packing plants. (6) Pickle plants. (7) Jams, jellies, fruit butter, frozen and canned fruits, cranberry sauce, dried fruits, and pureed fruits. (8) Nut meats, and nut butters. (9) Prepared vegetables, vegetable juices, dried vegetables. (10) Meat packing plants or sausage kitchens.

I. Filth in general or due to insanitary conditions uncorrelated with preparation, packing, or storage at factory. (example - destination and terminal warehouses) may be found associated with: (1) Fruit juices, syrups and coffee. (2) Flour, cornmeal, bakery products, cereal breakfast food, baby cereals, rye and buckwheat flours. (3) Cacao beans and confectionery. (4) Butter, cheese, cream, evaporated milk, dried skim milk. (5)Tullebees, white fish and ocean perch (parasites). (6) Condiments, seeds, mace, nutmeg, ginger, capsicum, cinnamon, and cassia. (7) Pureed fruits, olives, frozen fruits,canned fruit, dried fruits, small fruits (maggots). (8) Nut meats and nut butters. (9) Mushrooms, tomato products, canned peas.

J. Decomposition (or disease in meats) are commonly associated with: (1) Fruit juices,syrups, and coffee. (2) Cacao beans. (3) Cream. (4) Frozen eggs, egg whites, dried eggs, and shell eggs. (5) Canned herring roe, canned shrimp, canned salmon,etc.,fresh or frozen shrimp, fresh or frozen crabmeat fillets. (6) Mace,nutmeg, ginger, capsicum,cinnamon, and cassia. (7) Frozen fruits, fruit juice, jams,jellies, cranberry sauce,fruit butter, pureed fruits, canned fruits. (8) Dog foods. (9) Dressed poultry,rabbits. (10) Nut butters, nut meats (moldy). (11) Prepared vegetables, vegetable juices, dried vegetables, tomato products.

K. Deceptive packaging is commonly associated with: (1) Alimentary pastes,crackers, and cookies. (2) Confectionery. (3) Ground spices, panel bottles,etc. (4) Berry baskets,etc. (5) Canned poultry products (facing).

L. Short weight or volume are commonly associated with: (1) Confectionery. (2) Butter.

(3) Oysters (short volume). (4) Olive oil.

M. Misrepresentations in labeling are commonly associated with:(1) Fruit and fruit juices (shortage). (2) Wheat germ products. (3) Cane and maple syrup. (4) Salmon, mackerel and tuna (labels). Shrimp (misuse of inspection legend). Imported canned crabmeat (mislabled as to species). (5) Fresh and canned fruits and fruit products (misrepresentation of grade). (6) Stock feeds, grains. (7) Olive oil. (8) Fresh and canned vegetables (misrepresentation of grade).

N. Failure to declare mandatory statements (non-standardizing foods) is usually associated with: (1) Beverages and beverage materials (undeclared artificial flavor,color or preservatives). (2) Maple sugar (fenugreek); syrups (flavored);confectionery (ingredients and artificial flavor). (3) Flavors,spices, and condiments (artificial flavor). (4) Frozen fruits, pureed fruit, jams jellies, etc. (undeclared sugar,preservatives). (5) Canned poultry (mono-sodium glutemate).

O. Economic adulteration and substitution are commonly associated with: (1) Saccharin (for sugar); fruit juice (watered); coffee (substitutes). (2) Fruit candies (deficient in fruit ingredient). (3) Milk (filled). (4) Oysters and scallops (watered). (5) Fruit type flavors (fixatives); maple type flavors (fenugreek); pepper,cloves, mustard,horseradish. (6) Frozen fruit or juices (water); frozen or tree-dried citrus fruits. (7) Grain(water or screening); stock feed (protein or ammonia deficiency); dog foods (watering). (8) Nut butters (vegetable oils). (9) Olive oil (cottonseed oil or other substitutes). (10) Vegetable juices (watered). (11) Prepared meat products (cereal, milk powder, soy flour,etc.)

P. Standardized foods, misbranded or not in conformity are associated with: (1) Evaporated milk, cheeses (low butter fat). (2) Frozen or dried eggs (undeclared sugar,etc.). (3) Orange, vanilla, and lemon flavors (not meeting advisory standard). (4) Canned fruits, jams,jellies, preserves, fruit butter. (5) Canned vegetables, tomato puree and paste, tomato catsup, canned tomatoes.

APPLICATION FOR PERMITS

The Louisiana Sanitary Code Art. 200, states: "All restaurants, lunch counters, soda fountains, candy kitchens, and all places where food is served or prepared and served, to operate must obtain a permit in writing from the parish or municipal board of health annually . . . It is made the duty of all parish or municipal boards of health to prevent the operation of any hotel, lodging house, boarding house, restaurant, lunch counter, soda fountain, candy kitchen, or any place where food is served, or prepared and sold unless such a permit shall be issued unless the upkeep, complies with the provisions of this Code."

The Louisiana State Food, Drugs and Cosmetics Act. Sect. 7 (b) States: "The president (of Board of Health) is authorized to suspend immediately upon notice any permit issued under authority of this section if it is found that any of the conditions of the permit have been violated. The holder of a permit so suspended shall be privileged at any time to apply for the reinstatement of such permit, and the Board shall immediately after prompt hearing and an inspection of establishment, reinstate such permit if it is found that adequate measures have been taken to comply with and maintain the conditions of the permit, as originally issued or as amended."

The proprietor of any business as mentioned above obtains an "application for Health Department Permit" (Form 071641-SM-PHE 36) by applying to the local or state health department. The application must be correctly filled out and returned to:

(1) Local health department if the class of business is among the following: boarding house, coffee or lunch stand, delicatessen, fruit or vegetable market, grocery, hotel, tourist camp, ice cream parlor, lodging house, meat or fish market, restaurant, soda fountain, soft drink stand, swimming pool.

(2) State health department if the class of business is among the following: bakery, creamery, cold storage, confectionery, dairy, egg dealer, canning plant, ice cream factory, ice factory, macaroni or spaghetti factory, milk plant or depot, slaughter house.

Application for Health Department Permit

DATE________________

☐ TO THE LOUISIANA STATE DEPARTMENT OF HEALTH, NEW ORLEANS

☐ TO THE CITY OR PARISH BOARD OF HEALTH OF________________
TOWN OR PARISH

Sirs:

I (or we) hereby apply for Dept. of Health Permit and by this application agree to comply with the provisions of the State Sanitary Code.

________________ ________________
NAME OF BUSINESS OR FIRM SIGNATURE OF PROPRIETOR OR MANAGER

________________ ________________ ________________
STREET AND NUMBER CITY OR TOWN PARISH

Medical certificates for all food handlers must be attached to this application and will be returned with your permit.

BEFORE FILLING THIS APPLICATION SEE OTHER SIDE

071641—5M—PHE 36

On receipt of such application the local health department director or the representative of the State Health Department, which ever may be the case, will determine whether an inspection has been made of the business and whether this inspection shows that all requirements of the Sanitary Code have been observed. If all requirements have been met, the applicant is granted a "Permit to Operate", (Form 071641-10M-PHE 37) from the local or State Health Department, and only after receiving such a permit is the business legally allowed to operate.

PERMIT TO OPERATE

SANITARY CODE OF LOUISIANA

NO.________________ DATE________________

BOARD OF HEALTH OF________________LA.

________________, ________________,
(NAME OF BUSINESS) (KIND OF BUSINESS)

________________, HAVING AGREED TO COMPLY
(ADDRESS)

WITH THE PROVISIONS OF THE SANITARY CODE OF LOUISIANA, IS HEREBY GIVEN PERMISSION TO OPERATE THE ABOVE BUSINESS FOR ONE YEAR. THIS PERMIT MAY BE REVOKED FOR VIOLATION.

________________BOARD OF HEALTH

BY________________

071641—10M—PHE 37

The State Health Department usually sends only a letter of permission to operate and not a regular form. This letter serves the same as the "Permit to Operate". It must be remembered that every "permit to operate" must be renewed each year, and every registered food, drug, or cosmetic must be re-registered each year in order to be valid. It must also be remembered that "permits to operate" can be revoked at any time that the sanitary conditions of the place are found to violate the Sanitary Code.

Procedure for Registration, Collection of Fees, Issuance of Permits, Closure, Seizure of Foods and Drugs

REGISTRATION AND COLLECTION OF FEES

The Board of Health is authorized "to require all manufacturers, packers, or proprietors of processed foods, proprietary or patent medicines, prophylactic devices, and cosmetics, in package form, to register each separate and distinct product annually with the Board and to supply this Board with a sample of each such product upon request". (Act 142 of 1936 Section 17 (a) (2)).

Failure of any person or business operating under the above status to register each product "with the Board shall cause the sale of such product to be stopped and shall subject such article to seizure and condemnation..." (Section 17 (c)).

The "application for registration" form (062141-5M-PHE24) must be correctly filled out and submitted with list and labels. There should also be submitted at the same time a check, draft, or money order, of an amount equal to $2.50 per product to be registered, not to exceed $10.00. No registration of products will be granted unless the above terms are correctly executed.

Inspectors should make a thorough inspection of the place of business in their area for which application is made for registration. A copy of the inspector's report should be sent to the Central Office. If the Health Department wishes to investigate or is for any reason suspicious of the quality of a product, a sample may be requested. If on examination the product is found to be in violation of the law, it is subject to seizure and destruction even though it has been registered.

Manufacturers, packers, or proprietors of ice cream, soft drinks and non-alcoholic beverages, except non-alcoholic fruit juices, are exempt from the payment of examination and investigation charges here authorized since they are now required to pay a similar fee under provisions of Act 214 of 1928, and Act 201 of 1924. Manufacturers, packers, or proprietors, of products offered for sale or sold at retail only in their own establishments shall be exempted from the payment of the examination and investigation charges here authorized. When manufacturers, packers, or proprietors of products furnish evidence that such products have been registered with the United States Government, and that such products are produced under the supervision and have not been disapproved by the United States Government, such registration may be accepted, without the furnishing of labels or samples of such products.

On receipt of the application, fees and labels, if all are in order a printed "certificate of registration" is sent out. If for any reason the application is not in order, a receipt is mailed which acknowledges receipt of the application and fees and advises that the registration certificate will be sent out when everything is in order. It must be remembered that any infraction of the sanitary laws of the state at any time may subject the "Registered" products to regulatory action, either through seizure and destruction of the products, or injunction against the party responsible for their production, distribution or sale in violation of the law or by the Sanitary Code.

PROCEDURE FOR SEIZURE

I. Inspection

An inspection in accordance with the regular routine should first be made, and an official inspection sheet filled out and correctly signed.

II. Temporary Seizure

If any of the products are found to be in violation of the State Sanitary Code, or to have been processed, packed, labeled, stored or in any way handled in violation of the Food, Drug or Cosmetic Law or the aforesaid code, an "Official Notice of Seizure" form of the Louisiana State Board of Health should be filled out and signed, temporarily stopping the use, sale, and transport of the product.

III. Investigational Sampling

A. After the goods have been placed under seizure, one investigational sample should be

collected. With canned or packaged goods this investigational sample should consist of at least three cans or unit packages. In case of bulk goods, at least three pints of liquid or semi liquid products, and at least three pounds of dry products. These bulk samples should be taken from at least three different barrels, boxes, bags, crates, or other containers. Fruit or vegetables suspected of bearing excess spray residue should be sampled as follows:

B. Apples and Pears: If there is a visible spray residue, collect 25 apples at random, each from a different package. If there are less than 25 boxes, crates, baskets, or other containers in the lot to be sampled, collect a total of 25 apples from the containers available. These should be tightly packed in one bag to prevent rubbing.

C. Small Fruit (such as apricots, cherries, dates, figs, currents, peaches, prunes, nectarines, raisins): Each sample should consist of about 2 pounds, but not less than 50 pieces, and in case of the smaller fruits, not less than 100 pieces.

D. Vegetables (cabbage, cauliflower, peppers, squash, cucumbers, egg plants, etc.): Collect 10 specimens at random from each of 10 different boxes, crates, lugs, baskets, or other containers. If there are less than 10 containers, collect a total of 10 specimens from the lot available.

E. If different lots of growers' supplies are available, sample each lot separately as above outlined.

IV. Identification of Samples

At time of collection of samples, each sample should be sealed and identified with an official identification (seal) sticker (form 140) correctly filled out. In case of mermetically sealed containers, such as canned goods, it is not necessary to attach the sticker (form 140) although each can should be identified by scratching, with some sharp instrument, the sample number, date and inspector's name or initials on one end of the can. The cans may be wrapped in paper, placed in paper bags or otherwise packaged so that the sticker may be effectively placed to seal the package. "Seals" should not be attached to any bottle, package, can or other container so as to cover any portion of the label.
A "Sample Collection Data Sheet" should be filled out for each sample collected. This data sheet should be attached to or enclosed with the sample so that both sample and data sheet arrive together. A "sample" is considered as all the units or sub-divisions of the same material, collected at one time, from a lot or shipment of goods being offered in commerce. The samples should be sent to the head of the Food and Drug Section of the Louisiana State Department of Health.

Form 140

FORM 140.

LOUISIANA STATE DEPARTMENT OF HEALTH

STATE OF LOUISIANA
DEPARTMENT OF HEALTH
FOOD AND DRUG SECTION

SAMPLE No. ____________

DATE ____________

INSPECTOR ____________

Sample Collection Data Sheet

LOUISIANA STATE DEPARTMENT OF HEALTH
SAMPLE COLLECTION DATA SHEET

Sample of ____________ Sample № 5351 B

Label ____________
(NAME OF PRODUCT, BRAND, CODES, WAREHOUSE NUMBERS, ETC.)

____

Amount of sample ____________ Amount of material left ____________

Manufactured or Packed by ____________ Address ____________
(LEAVE BLANK IF UNKNOWN)

Received by Dealer from ____________ Address ____________

Dealer ____________ Address ____________

Collected on ________ at ________ A. M. P. M. Delivered to ________ on ________ at ________ A. M. P. M.

Length of time in stock ____________

State test desired ____________
(REASONS FOR COLLECTION)

Remarks ____________

____________ SIGNATURE OF SALESMAN

____________ SIGNATURE OF INSPECTOR

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V. Report From Food and Drug Section

Wait for report from Food and Drug Section, and proceed further, only in accordance with the instructions given by that section.

VI. Disposal of Seized Material

A. If material is to be destroyed, proceeed as directed in report from Food and Drug Section. No material is to be destroyed without official notice from the State Department.

B. If material is to be released, do so by filling out "Official Release Notice" form.
No seizure should ever be attempted without first conferring with the Director of the Health Unit of that parish where the seizure is to be effected.
If the owner agrees to destroy material that is grossly in violation of the State Sanitary Code and obviously needs no further examination to determine the violation, get a written certified statement from him as to that effect, before it is destroyed. Send a complete report of the procedure and amounts and kinds of materials to the head of the Food and Drug Section.
Enough samples should be sent to Food and Drugs Section to represent an adequate sample of the materials. Samples must be paid for by the health department only if an excessive quantity is demanded. The Louisiana State Food, Drugs, and Cosmetic Act authorizes the Board of Health "to require all manufacturers, packers, or proprietors of processed foods . . . to supply this Board with a sample of each product upon request".
If milk is seized the same procedure as above outlined must be followed. The seized milk must be put in cold storage. The storage fees must be paid for by the department of health. If the dairyman requires payment for samples of milk collected, he is in the right if the sample exceeds one pint. The Louisiana Milk Code provides that "all persons, firms or corporations engaged in the grading, handling or selling of milk or other dairy products shall deliver to any representative of the state or local board of health on demand a sample of the milk or other dairy products in his possession (not to exceed one pint) and any refusal to deliver such sample in his possession shall be deemed a violation of this code".

CLOSURE PROCEDURES

I. First Inspection

An inspection in accordance with the regular routine should first be made, and an official inspection sheet filled out and correctly signed. The proprietor is notified by the inspector that the corrections must be made within a reasonable length of time (usually 10 days; less than 10 days for critical violations).

Being "reasonable" in public health procedure is one of the most important factors considered by the courts in prosecuting cases of violation against the public health. This should not be interpreted to mean being indecisive or slow in implementing the provisions of the Sanitary Code, but rather in being precise, alert, and ready to act without prejudice or discrimination, and being able to evaluate the length of time to be allowed for the correction of a particular condition.

II. Second Inspection

At the end of the period allowed after the first inspection to make necessary corrections, a second inspection is made and an inspection form filled out. If no satisfactory progress is being made to correct the violation, the inspector notifies the health officer, who in turn notifies the proprietor to appear at the health unit office for a hearing at a definitely designated time. This notification is sent by registered mail, so that the proprietor may have no alibi if the case happens to go further to the courts. If the violation is of a nature needing immediate attention, the sanitarian may in person notify the proprietor to appear for hearing before the health officer (if the sanitarian knows before hand that the health officer will be available).

III. Hearing

The health officer must inquire why corrections were not made, and if the reasons given by proprietor are justifiable, and assurances of willingness are shown that the corrections will be made as soon as possible, the health officer will allow a reasonable extended time for the corrections of violations. If the proprietor is obstreperous and excuses are not justifiable, or if no excuses are made, then the health officer should immediately file an affidavit for prosecution. If the proprietor does not appear at the hearing nor informs the health officer beforehand of any adequate reason for not appearing, charges are filed without further ado.

If it is necessary to file an affidavit, it should be first be for violation of the State Food, Drug, and Cosmetic Act:-
Section 20 (a) (1) "The introduction or delivery for introduction into commerce of any food, drug, device, or cosmetic that is adulterated or misbranded; " and
Section 20 (a) (2) "The adulteration or misbranding of any food, drug, device, or cosmetic in commerce"; with the specific adulteration defined under
Section 3 (a) (4) "If it (food) has been prepared, packed, or held under insanitary conditions whereby it may have become contaminated with filth, or whereby it may have been rendered injurious to health"; or both Section 2 and Section 3 (a) (4), and then in addition, violations of the
State Sanitary Code under the specific chapter and articles applying to the offense.

The above mentioned item of Section 3 (a) applies only to insanitary operation of food handling establishments, if the violation is in relation to drugs, section 3 (a) (4) is substituted by Section 8 (a) (2). If the violation is in relation to cosmetics then Section 3 (a) (4) is substituted by Section 11 (c). If the violation is in relation to other types of adulteration or to misbranding then the pertinent sections should be cited.

IV. Third Inspection

If at the time of the hearing additional time is allowed,then the inspector should report at the expiration of the time whether or not the changes have been made; and if such corrections have still not been made, then an affidavit is immediately filed with the District Attorney as above outlined.

The Food, Drugs, and Cosmetic Act states that "It shall be the duty of each district attorney to whom the Board reports any violation for institution of criminal or injunction proceedings under this Act, or to whom any health, food or drug officer of the state, or political subdivision thereof, presents evidence satisfactory to the district attorney of any such violation, to cause the appropriate proceedings to be instituted in the proper courts without delay." Section 25.

The health department makes no closures itself. Closures must be made through the court and carried out by the police authority. Although inspectors or representatives of the health department are empowered to make arrests under certain conditions (Act 79 of 1921, Section 9), this duty is best delegated to the police authorities, since health work should connote "service and education" rather than "force".

If proceedings are instituted against a violator of the Sanitary Code, and the court acts favorably to the health department, it does not mean that the place of business of the violator is immediately closed. According to the amended Act 79 of 1921 and the Louisiana Food Drugs and Cosmetic Act of 1936, penalties of fines and imprisonment are defined for offenders, but in order to close an establishment it becomes necessary to institute injunction proceedings. It is the duty of the district attorney to institute such proceedings if requested by the Board of Health. The amended Act 79 of 1921 does not define any power to institute injunction proceedings against a violator, but the Food, Drugs and Cosmetic Act of 1936 does grant that power.

To institute injunction proceedings is a serious matter. In our democratic form of legal procedure, the injunction is a very severe measure to invoke. It should be used only in recalcitrant cases and emergencies.

In a great many instances an establishment may be closed by the owner or manager of his own accord if properly advised as to the insanitary condition of his plant and the health hazard it is to the community. Particularly is this true if he is advised that if he does not close to fix up as the law requires, that it will be necessary to institute court action. Knowledge that the unfavorable publicity, attendant with such action, will hurt his business is a potent weapon.

Reference: Louisiana Sanitary Code

Malaria and Mosquito Control

The three most important diseases carried by the mosquito are malaria, yellow fever, and dengue fever. The last epidemic of yellow fever occurred in the United States in 1905 in Louisiana where 9,321 cases were reported with 988 deaths. Since then this disease has not visited our shores. It apparently first reached this country in the middle of the 17th century and caused 100,000 deaths till it was finally exterminated in 1905. Of these deaths 40,000 occurred in Louisiana. Quarantine measures were mostly responsible for extermination of this disease in the United States. Dengue was first recognized in this country in the middle of the 18th century. Although it does not cause many deaths, it is indeed a troublesome disease in those areas where it is prevalent. It occurs mostly in the South and has never penetrated north of Virginia.

Malaria was known very early in medical history having been already described by Hippocrates more than 2000 years ago. Chinese medical works of more than 1000 B.C. refer to a disease which undoubtedly was malaria. It has been a source of much death and sickness through the tropical and subtropical world. The disease is sometimes called the "Scourge of the South". It has been estimated that 3,000,000 cases of malaria occur in the United States annually. The losses through death, cost of medical treatment, losses to enterprises in malarious regions through inefficient labor and other factors, were estimated to be at least $100,000,000 a year. Malaria has been controlled to some extent, but has never been adequately controlled in southern United States. Quarantine alone is not effective because malarious people may carry the parasite in their blood for many years. Therefore, adequate treatment and control of the malaria carrying mosquitoes are necessary for the extermination of this disease.

Another tropical disease, filariasis, not ordinarily found in the United States is transmitted by a variety of mosquitoes. There is an endemic area near Charleston, South Carolina where filariasis is found.

There are other diseases such as encephalitis lethargica, equine encephalomyelitis and infantile paralysis which are suspected of being transmitted by mosquitoes, but as yet we have no evidence that the mosquito carries them in nature.

Besides carrying diseases, mosquitoes are pests, causing much irritation, loss of sleep and depreciation of value of land.

The four most important groups of mosquitoes in the United States which are related to disease carrying are: (1) The genus Anopheles, (2) The genus Aedes, (3) The genus Culex, (4) The genus Psorophora.

The Anopheles group are the malaria carriers. The most dangerous malaria carriers in this country are Anopheles quadrimaculatus and Anopheles maculipennis, the former occurring in south and southeastern states and the latter on the west coast and upper Mississippi valley. Anopheles crucians sometimes carries malaria. Anopheles albimanus is a malaria carrier on the Mexican border. Anopheles pseudopunctipennis carries malaria in Central and South America but not in this country. Anopheles walkeri, Anopheles punctipennis, Anopheles atropos and Anopheles barberi do not usually transmit malaria. Of all these, the three most common Anopheles mosquitoes in southeastern United States are: (1) Anopheles punctipennis, (2) Anopheles quadrimaculatus, (3) Anopheles crucians. The Anopheles mosquitoes are the only vectors of malaria.

It was once thought that the species Aedes aegypti was the only one which carried yellow fever, but in the jungles of Brazil, yellow fever has been found in epidemic form which is not associated with Aedes aegypti. This is called "jungle fever". It has been found that some other mosquitoes may harbor the yellow fever virus without being able to transmit it. Aedes triseriatus which is a very common mosquito appears to be able sometimes to transmit this disease from animal to animal. The mosquitoes of the genus Aedes which are commonly found in southeastern United States are: (1) Aedes aegypti, (2) Aedes vexans, (3) Aedes sollicitans, (4) Aedes taeniorhynchus, (5) Aedes triseriatus, (6) Aedes atlanticus, (7) Aedes canadensis, (8) Aedes dupreei, (9) Aedes infirmatus, (10) Aedes thibaulti.

Dengue fever is found in the southern part of this country and is transmitted by Aedes aegypti. It is suspected that Culex quinquefasciatus and possibly other mosquitoes may transmit this disease.

The common species of the genus Culex that are found in southeastern United States are:

(1) Culex quinquefasciatus, (2) Culex restuans, (3) Culex salinarius, (4) Culex apicalis, (5) Culex erraticus. Several other smaller groups of mosquitoes but yet fairly common in southeastern United States are: (1) Genus uranotaenia, (2) Genus psorophora, (3) Genus mansonia, (4) Genus theobaldi. The common species of these four groups in southeastern United States are: (1) Uranotaenia sapphirinus, (2) Psorophora columbiae, (3) Psorophora ciliata, (4) Psorophora ferox, (5) Psorophora howardi, (6) Psorophora cyanescens, (7)Psorophora varipes, (8) Mansonia perturbans, (9) Theobaldia inornata.
Some of the species named above have been called by a number of other names in the past. In order to avoid confusion, some of these synonyms are outlined below:(1) Culex quinquefasciatus (Culex pungens, Culex fatigans), (2) Culex salinarius (Culex nigritulus), (3) Culex restuans (Culex territans), (4) Culex apicalis (Culex territans, Culex testaceus, Culex saxtilis), (5) Culex erraticus (Culex abominator, Culex egberti, Culex peribleptus, Culex pose, Culex degustrator, Culex leprince, Culex homeopas, Culex inhibitator, Melanoconion atratus), (6) Aedes aegypti (Stegomyia fasciata, Stegomyia calopus, Aedes calopus, Aedes argenteus), (7) Aedes vexans (Aedes sylvestris, Culex stimulans), (8) Aedes taeniorrynchus (Taeniorynchus niger), (9) Anopheles quadrimaculatus (Anopheles annulinanus), (10) Anopheles punctipennis (Anopheles perplexens, Culex hyemalis), (11) Anopheles pseudopunctipennis (Anopheles franciscanus), (12) Anopheles albimanus (Anopheles albipes), (13) Anopheles maculipennis (Anopheles occidentalis, Anopheles lewisi, Anopheles selengensis), (14) Psorophora columbiae (Culex jamaicensis, Janthinosoma floridense, Aedes jamaicenis), (15) Psorophora ferox (Aedes sayi, Janthinosoma musica, Psorophora sayi, Culex posticatus), (16) Psorophora ciliata (Psorophora ctites).

IMPORTANT BASIC HABITS OF THE IMPORTANT AND COMMON SPECIES OF MOSQUITOES IN SOUTHEASTERN UNITED STATES

A. Breeding Habits and Distribution

Anopheles - The following nine species of Anopheles are found in the United States and are described here because of their wide distribution, and because by experiment, most of these have proved to be susceptible to malaria infection, and several of them have been infected with malaria parasites under natural conditions.
It can generally be stated that the Anopheles have a preference for clean, stagnant water with vegetation. But it is by no means a rarity to find them breeding in artificial containers, in muddy, dirty, and polluted water and in a wide range of other breeding places. Therefore, it must be understood that, although, the following discussion outlines the most important preferences for certain Anopheles mosquitoes, it by no means intends to convey the idea that they may not breed in a host of the other environments.

In the United States, malaria control by anti-mosquito measures should be directed principally against quadrimaculatus and maculipennis, the two most important malaria carriers in this country.

1. Anopheles quadrimaculatus is the important malaria transmitter in the South and Southeast and is usually termed a "Pond Breeder", as it is rarely found in flowing water. It frequents permanent bodies of water usually well grown up with vegetation, such as fresh water pools, ponds, shallow lakes, rice fields, barrow-pits, lake margins and ponded swamps. It apparently prefers neutral or slightly alkaline water rather than acid water. There is considerable evidence that the range of types of places used by this mosquito is the widest of all Anopheles. Any place in which any Anopheles is breeding in Louisiana except possibly Anopheles barberi may be considered a potential breeding place for Anopheles quadrimaculatus.
2. Anopheles maculipennis, is the most important malaria carrier of the far West and breeds, by preference, in shallow sunlit pools of clear water containing green algae, such as wayside pools, irrigation canals or drainage ditches, seepage areas and hoof prints.
3. Anopheles punctipennis occurs in southern Canada and throughout the United States. It breeds chiefly in clean water such as streams, stream fed pools, and the more permanent rain water pools. This species appears the only one of the North American Anophelines that is commonly found in streams.
4. Anopheles crucians occurs principally in the coastal region of the United States from New York to Texas, and in the lower Mississippi Valley. Two races of this species are present in the United States, one inhabiting fresh water and preferring the same places as quadrimaculatus, except that it likes slightly acid waters, the other race preferring salt water such as salt marshes.
5. Anopheles pseudopunctipennis has been found in California, Arizona, New Mexico, western Texas, and on rare occasions as far east as Tennessee. It breeds in wayside sunlit pools especially the semi-permanent ones left by seasonal rains in semi-arid country. It may breed in same places as maculipennis.
6. Anopheles walkeri is rather rare and few records of its breeding places are available. Apparently it breeds in permanent or semi- permanent water containing much vegetation. It has been found in water covered by water hycinths (Mississippi), in cattail marshes

(New York and Florida) and in rice fields (Arkansas).

7. Anopheles atropos is likewise a species seldom encountered. It breeds in brackish or salt water pools along the Gulf and Atlantic coasts of this country, having been reported from Louisiana, Mississippi, Alabama, Maryland, Virginia, and Florida. The larvae have been found in grassy or algae-filled pools, on the marshes, and the shallow water on muck soils.

8. Anopheles barberi occurs throughout the south-eastern part of the United States, but is extremely rare. It breeds exclusively in water in tree holes.

9. Anopheles albimanus is of extremely rare occurrence in the United States, but is important in tropical America. Its breeding habits in United States have not been observed.

10. Aedes aegypti, the yellow fever mosquito, is thoroughly domesticated, and seldom takes blood of any animal but man. It breeds in artificial containers, always near human habitation. It may be easily overlooked, since the larvae, when disturbed, sink rapidly to the bottom of the container and rise again very slowly. Therefore, unless a vessel is completely emptied, the larvae may remain behind in the last few drops of water. This species objects to polluted water. It is found in places to which it is imported.

11. Aedes vexans develops in woodland pools or in open swamp-pools. It also breeds in temporary pools in pasture lands.

12. Aedes sollicitans is the salt marsh or true "Jersey" mosquito and passes its larval life in salt or brackish pools on tidal marshes. It breeds to some extent in fresh water, and has been found in water below normal salinity at New Orleans and in the vicinity of oil and gas fields. This may be important in explaining the explosive outbreaks occurring in such fields hundreds of miles from the seacoast when accidents result in formation of salt marshes.

13. Aedes taeniorhynchus propagates in the same places and has the same habits as Aedes sollicitans.

14. Aedes triseriatus breeds largely in water in the hollows of trees and logs and in artificial containers, both near to and remote from habitations.

15. Aedes atlanticus breeds in ground pools, temporary or permanent, in woods or open country.

16. Aedes canadensis breeds in ground pools, usually in woods.

17. Aedes dupreei breeds in same places as Aedes canadenisis.

18. Aedes infirmatus breeds in same places as Aedes canadensis and occasionally in holes in trees and logs.

19. Aedes thibaulti breeds usually in stump holes or rotten stumps.

20. Culex quinquefasciatus prefers organic polluted water in which to propagate, and is the common species found in cesspools and open sewers. It may be considered axiomatic that, when large numbers of Culex are found in outhouses and barns in any locality under control, some sewage contamined breeding place, cesspools, catch basin, or sewer, exists undiscovered in the near vicinity. They breed prolifically in old ensilage water, laundry and milk wastes, etc. The adults persist for a number of weeks after their breeding place has been destroyed.

21. Culex restuans usually prefer cleaner water than quinquefasciatus but still obviously dirty and is more frequently found in rural sections. It is often found breeding in rain barrels but not nearly as often as is Culex salinarius.

22. Culex salinarius is often found in fresh water pools near the sea, but occurs inland as well, associated with restuans and apicalis. It is often found also with Aedes sollicitans in brackish water.

23. Culex apicalis in the larval stage usually inhabits permanent pools filled with aquatic vegetation. It is often associated with Anopheles larvae. It may also be associated with Culex restuans and Culex salinarius in rain barrels and other artificial containers.

24. Culex erraticus is very common in permanent bodies of water associated with the larvae of Anopheles and of Uranotaemia saphirinus.

25. Psorophora ciliata is cannibalistic as a larva, preying upon the larvae associated with it in temporary puddles and puddles close to habitations. Lays its eggs on mud or dry ground in depressions.

26. Psorophora columbiae is the large larva commonly found in rain water pools, which grows with such amazing rapidity in warm weather. Eggs are laid in the dry mud at the bottom, and hatch almost immediately after being covered with water. Under favorable conditions, the life cycle is completed in five days after the eggs hatch.

27. Psorophora ferox propagate in woodland pools. Habits are similar to Psorophora ciliata.

28. Psorophora howardi - habits are similar to Psorophora ciliata.

29. Psorophora cyanescens breeds in temporary pools and mud puddles usually near habitations.

30. Psorophora varipes breeds in temporary pools in woods.

31. Theobaldia inornata breeds in pools in woods, sometimes breeds heavily in septic tank effluents and sewage.

32. Mansonia perturbans is widely distributed in eastern and southern states. It breeds in marshes, ponds, and lakes having thick growths of aquatic vegetation (cattails,

aquatic sedges, pickerlweed, frog's bit, water lettuce, arrowhead, spadder-dock, water hyacinths) to the roots of which the larvae and pupae attach themselves by means of their air-tubes. They never come to the surface until ready to evolve into adult stage. The eggs are laid on the surface of the water in rafts similar to those of Culex. Larval development is extremely slow and in this stage it may spend winter in water.
7. Uranotaenia sapphirinus resembles Anopheles larva in the larval stage, as it takes a position parallel with the surface of the water when feeding. It can be distinguished by the presence of a breathing tube, which is absent in Anopheles. This species is commonly associated with Anopheles larvae in pools with much vegetation.

B. Seasonal Breeding

1. Anopheles - There seems to be some evidence of a seasonal rotation of Anopheles species in that punctipennis is the earliest on the wing in great numbers, with crucians coming second, but disappearing in hot weather, while quadrimaculatus appears latest and seems to persist through the summer. In the fall the above order appears to be reversed. Generally considered, Anopheles are heaviest in summer, but fairly heavy in spring and fall, and even during prolonged warm spells in winter. This pattern fits Anopheles maculipennis in the far west.
2. Aedes - Aegypti is usually important only in warm weather, but may breed inside warm buildings in cold weather. Vexans is an early spring species in the south. Triseriatus is an almost year round breeder. Most of Aedes will breed in the warm season and not in very cold weather. Some of the species show a great tendency to produce in one enormous brood each spring of the year.
3. Culex - quinquefasciatus breeds most intensely in summer, but also in cool weather and not in coldest weather. The same holds true for most Culex species. Culex apicalis has a peak production in cold weather, persist through the cold season. Culex restuans tends to a peak production in cool weather.
4. Psorophora - These breed largely from early May through the cool seasons. Psorophora varipes is a one brood species appearing in the spring. Psorophora cyanescens produces in hot weather only. Most Psorophora have their peak production in hot weather.
5. Mansonia perturbans - They are present from March to December with peaks in May and August-September with only desultory production during the rest of the year.

C. Flight Range

Anopheles: A knowledge of the distance of flight of the various species of Anopheles that convey malaria is of great importance in control operations. It is generally considered now that the flight range of these mosquitoes is not more than a mile, therefore, control of production within a radius of about 1 mile will ordinarily protect the human population from malaria. Quadrimaculatus may have a flight of almost 2 miles, while albimanus may have a flight range of $1\frac{1}{4}$ miles.
Aedes: Aegypti has a flight range of not over a few hundred feet. Triseriatus probably has a short flight range. Aedes sollicitans, the salt marsh mosquito, may migrate as far as 40 miles from where it propagates. There is evidence Aedes taeniorynchus flies as far as sollicitans, and that one of its subspecies occurring in Florida (Aedes niger or Aedes portoricensis) flies 95 miles from land. Most other Aedes mosquitoes have flight ranges much shorter than 1 mile.
Culex: The Culex group usually does not have a flight range exceeding one mile. Some culices may fly over a mile, especially salinarius.
Psorophora: These have very short flight ranges, being seldom over 200 yards.
Mansonia perturbans: These have it is believed, a flight range of several miles.

D. Length of Stages Necessarily Spent in Water

Anopheles, Culex, and most of Aedes remain in their water stages at least 8 to 10 days, but this varies according to temperature and other conditions.
Psorophora have aquatic life stages usually of 3 or 4 days.
Mansonia have it is believed long aquatic life of 3 or more months, remaining over winter in many instances.

E. Biting and Other Habits

Anopheles. Punctipennis bites on porches after dusk and is often found underneath occupied houses. Quadrimaculatus, and sometimes crucians, will enter houses freely. The former after dusk while the latter will bite at any time of the day even in direct sunlight. The Anopheles bites are usually not very annoying, and the peak of biting is at dusk. Quadrimaculatus will also bite in the shade during the day and sometime in sunlight.
Aedes. Aegypti bites only during the daytime or under lights. Their bites are very annoying especially around the ankles, knuckles and elbows. Sollicitans and other salt marsh species usually attack in hordes both day and night but especially in late afternoon. Other species of the Aedes group usually bite both day and night.
Psorophora. These are extremely voracious biters both day and night. They not infrequently kill live stock.

Uranotaenia. These are seldom seen and seldom bite. If culverts are used as catching stations, adults will be seen not infrequently.
Mansonia perturbans. Are very severe biters, starting after dusk and during early part of night.

F. Day Resting Places
Where they may be found during day if present in area. To know this will serve as a gauge as to which species must be controlled and to determine the effectiveness of control measures.
Anopheles are usually found resting in the daytime in dark or semi-dark places which are cool, humid, and out of reach of strong air currents. The daytime resting to which the attention of collectors should be directed are: (1) Inside houses, especially the sleeping rooms and porches. (2) Beneath elevated dwelling and other building. (3) In stables and other shelters for domestic animals. (4) In privies. (5) Under bridges and in culverts. (6) On the shadyside of road-cuts and the like. (7) In the interior of hollow trees. (8) In boxes and in barrels under shelter.
Aedes aegypti are found in and near habitations. Most of Aedes are found near their breeding areas.
The various Culex groups found more or less in same place as Anopheles.
Psorophora are found in proximity of breeding areas.
Mansonia perturbans are found resting in shady, moist places, but their daytime resting places are difficult to find except by being bitten.

G. Life Cycle of the Mosquito
There are four stages in the development of mosquitoes: The eggs, the larvae or "wiggler", the pupae, and the adults. According to the species of mosquito, the eggs are layed on the surface of the water, at the edge of the water, on the wet mud, or on the dry mud. The shape of the egg also depends upon the type of mosquito. The Culex egg is usually oval shape and clustered together in the form of a raft which floats on the surface of the water. The Aedes eggs are elongated ovals laid singly on damp soil at edge of water or in moist depressions. Some Aedes may lay eggs on the water surface. The Anopheles eggs are shaped like boats with air chambers on each side. They are layed singly. Some types of mosquitoes may lay their eggs in small dry depressions in the ground where they may remain all winter and in spring hatch out when coming in contact with water. Those eggs which are so layed may remain viable in the dry state for five years.
The larva hatches from the egg and must have a watery environment in order to live, grow and develop. This stage feeds on protozoa, algae, decomposed organic matter, bacteria and colloids. Some feed at the surface of the water, such as Anopheles; others, the Culex and Aedes, feed below the surface. Larvae have breathing apparati at the lower end of their abdomen. All larvae except Anopheles have well developed breathing tubes. All larvae pierce the surface film of water with their breathing tubes to obtain atmospheric air except Mansonia which obtains its air by means of saw-tooth breathing apparatus from plant roots. Larvae moult or shed their skins 4 times - the fourth moult changes the larvae into the pupae. Larvae may remain in the water or in ice over winter. The larval period is from several days to several months, depending upon the species and the temperature.
The pupal period lasts on an average of 2 days. It does not moult nor can it remain in the water or ice over the winter. This is also an aquatic stage. It cannot live, grow, or develop without a water environment. The adult develops from the pupae. Under favorable conditions the usual life period of the house mosquito in midsummer is about 2 or 3 weeks, but this may vary widely with changing conditions. Some mosquitoes may hibernate in the fall and live to the following spring.

SUGGESTIVE ASSOCIATION OF MOSQUITOES GROUPED ACCORDING TO TYPICAL LARVAL HABITATS FOR SOUTHEASTERN UNITED STATES (1)

Artificial Containers: Aedes aegypti, Aedes triseriatus, Culex quinquefasciatus, Culex restuans, Culex salinarius, Culex apicalis (seldom).
Permanent Pools: Anopheles quadrimaculatus, Anopheles crucians, Culex apicalis, Culex erraticus, Culex salinarius, Culex restuans, Mansonia perturbans, Uranotaenia sapphirinus.
Temporary Rain Water Pools: Psorophora ciliata, Psorophora columbiae, Psorophora ferox, Psorophora howardi, Psorophora cyanescens, Psorophora varipes, Aedes vexans, Aedes sollicitans, Aedes taeniorhynchus, Aedes atlanticus, Aedes canadensis, Aedes dupeei, Aedes infirmatus, Aedes thibaulti.
Salt Marshes and Brackish Water: Aedes taeniorhynchus, Aedes sollicitans, Anopheles atropos, Anopheles crucians.
Waters Covered with Water Hyacinths, Cattail Marshes: Anopheles walkeri, Mansonia perturbans.
Irrigation Water (including seepage): Anopheles maculipennis.
Rice Fields: Anopheles maculipennis, Anopheles quadrimaculatus, Anopheles walkeri.
Flood Waters, and Open Swamp Pools: Aedes vexans.

Streams: Anopheles punctipennis.
Tree Holes: Aedes triseriatus, Anopheles barberi, Orthopodomyia signifera.
Cesspools and Open Sewers: Culex quinquefasciatus.
Woodland Pools: Aedes vexans, Aedes atlanticus, Psorophora ferox, Psorophora varipes, Mansonia perturbans, most other Psorophora and Aedes.

It must be noted that there is scarcely any such classification as "Typical Breeding Places" for mosquitoes except possibly in a very general way, since there is a great deal of "atypical" breeding among mosquitoes. It is therefore necessary to remember that the above classification of breeding places is not to be considered too faithfully less failure and confusion follow. It is merely given as a general starting point and it is expected that the sanitarian be constantly aware of variations.

A CLASSIFICATION OF MOSQUITO ABATEMENT METHODS (1)

The following classification is given for the purpose of acquainting the sanitarian with the fact that the methods of mosquito abatement are numerous, and in a number of instances very technical, requiring good engineering skill. It is good to realize that all phases of sanitary science has much complicated background even in cases where methods are apparently simple. The classification should stimulate the sanitarian to study further and acquaint himself with the details, as far as it is possible, of the extensive field of mosquito control.

AGAINST AQUATIC STAGES

- I. Mechanical
  - A. Drainage
    - 1. Open
    - 2. Subsurface
    - 3. Vertical
  - B. Pumping
    - 1. Surface waters
    - 2. Subsurface (well) water
  - C. Diversion of water
  - D. Channeling of streams and sloughs
  - E. Filling in low areas
  - F. Restriction or control of excessive use or needless abuse of irrigation water
  - G. Miscellaneous
    - 1. Screening or mosquito-proofing cisterns, wells and water containers
    - 2. Removal or destruction of unnecessary artificial water containers
    - 3. Removal of protective vegetation or floatage
    - 4. Repair of leaks or defects in water supply, plumbing, or drainage systems
    - 5. Tree surgery
- II. Toxic
  - A. Petroleum derivative oils
    - 1. Direct refinery products
    - 2. Treated oils, for increased toxicity or increased spreading capacity
    - 3. Reclaimed waste oils
  - B. Larvicides
    - 1. Emulsions, pyrethrum, cresylic or phenolic
    - 2. Soluble poisons
    - 3. Solids (powdered), Paris green
  - C. Toxic cases
- III. Naturalistic
  - A. Chemical
    - 1. Changing salt (NaCl) content of water, salinification, freshening
    - 2. Pollution with decaying vegetation, with sewage or wastes
    - 3. Stagnating
  - B. Physical
    - 1. Drying by agricultural use or by special plantings
    - 2. Natural fills (silting)
    - 3. Flooding, controlled reflooding and redraining

AGAINST ADULT MOSQUITOES

- I. Mechanical
  - A. Screens
    - Nets
    - Special Clothing
  - B. Deterrents
    - Fans
    - Exposure to wind
  - C. Trapping
    - 1. Baited traps
    - 2. Light traps
  - D. Hand catching and killing
    - 1. Active season killing
    - 2. Winter killing
  - E. Removal of houses or villages to sites beyond flight range
- II. Toxic
  - A. Sprays
  - B. Fumigants
  - C. Chemical repellants
- III. Naturalistic
  - A. Chemical
    - 1. Administration of drugs like sulphur which causes odorous perspiration
    - 2. Creating repellant carriers of odorous plants
  - B. Physical
    - 1. Clearing, destruction, or removal of shelter
    - 2. Creation of plant barriers to flight
    - 3. Rendering dwellings, especially bedrooms, unattractive to mosquitoes

4. Setting water in motion
5. Intermittent drying
6. Fluctuating water levels
7. Flushing or sluicing, automatic, hand operated
8. Agitation, volumetric (see 3 & 4)
9. Shading to exclude sunlight
10. Clearing to expose to sunlight
11. Muddying

C. Biological
1. Introduction of natural enemies
   Predatory fish, other aquatic predators
2. Changing flora and fauna to unsuitable or competitive types
3. Elimination or destruction of aquatic food supplies

C. Biological
1. Introduction of natural enemies
   Predatory crepuscular birds, etc.
   Parasites
2. Deviation by animals
3. Minimizing available harborage for winter hibernation

GENERAL PRINCIPLES OF MOSQUITO ABATEMENT

Considering the great diversity in types of breeding places, types of food preferred, flight habits, ability to transmit disease, and economic effect of the various species of mosquitoes, we begin to realize the complexity of the problem of control. Generalized rules of thumb are not to be too closely followed, but certain definite simple rules can be applied by the sanitarian with rather good results in instances where the problem is not too extensive and complex. Success in control depends upon exact knowledge of the species of mosquitoes in the particular region to be placed under control, of the habits of each particular species or sub-species, and of the appropiate methods for abatement of each species. Attention is directed to the use of naturalistic control methods which aim to effect, at relatively small cost, simple changes in environment to make it unsuitable to the breeding of the particular species in that region. The naturalistic methods are in most instances of an engineering nature and require highly skilled personnel as directors of the work. There is evidence that these methods will in the future become more used and developed, since they lend themselves to large scale projects for mosquito control. There is little doubt that the future will see mosquito control projects whose magnitude is today scarcely imaginable. Let it be understood that the naturalistic methods are still in the experimental stage, but that they hold the most promising solution for large scale mosquito control. In the presence of a mosquito transmitted disease a selective attack (species sanitation) against the vector species is of primary importance, especially where limited funds make it impractical to attempt a program for the abatement of all types of mosquito breeding.

Reducing the production of mosquitoes is principally a matter of reducing or eliminating the water in which mosquitoes breed, or by appropriate naturalistic methods rendering such water unsuitable for mosquito breeding. If, after this has been accomplished to the greatest practical extent, there still remains some mosquito breeding, then this residual production must be controlled by supplemental measures, such as the application of oils, Paris green, or other larvicides. But the use of oils and larvicides for the destruction of the aquatic stages of mosquito life must always be looked upon as a secondary method of attack, the necessity for which should be reduced to a minimum by the primary methods of drainage, filling, constant level flooding, controlled reflooding, and other methods. But these secondary methods are by force of necessity still being used as primary methods due to purely economic reasons. There are so many communities in our country which are too poor to make an outlay of money at one time that would be sufficient to carry on a control program by the primary methods, but the fact remains that we are not far off from the day when the primary methods will be used where they should prevail.

Perfection of detail and continuity of effort are important in effective control work. A sustained attack, year after year will produce better ultimate results than an intense attack in one year followed by comparative neglect and inaction.

PRELIMINARIES TO ABATEMENT PROCEDURES:

Before any mosquito abatement project is begun, it must be planned and organized. The proper personnel engaged and adequate equipment and supplies provided. This is the ideal and logical method of procedure. But in the "rough and ready" activity of every day work, where adequate personnel and money are usually lacking, and where emergencies arise that require immediate action, these preliminaries are by-passed and the work is begun on a more or less trial and error basis, relying on the effectiveness of the old standby cure-all methods of oiling, spraying, and ditching. And it cannot be gainsaid that these methods will in a good number of instances give results if correctly carried on. It would be folly to disregard these preliminaries in large scale mosquito control projects.

The preliminary report should include data and recommendations on the following matters.
1. The boundaries of the region which should be included within the project.
2. Population, area, and assessed valuation of the region.
3. The location and area of the principle breeding areas.
4. Tentative suggestions as to the best methods of control for each principle breeding area.
5. The species of mosquitoes involved, with a brief discussion of their breeding habits.
6. The amount and types of domestic mosquito breeding within the region, and measures for its abatement.
7. The probable organization that will be required, including personnel and equipment.
8. Detailed preliminary estimate of cost, both for permanent work and for regular maintenance; and comparative costs for areas of similar size and conditions.
9. The economic losses caused by mosquitoes in the area, and the economic savings which should result from adequate abatement measures.

METHODS OF ABATEMENT - Drainage and Filling

1. The Aim: (1) To remove all excess storm water into a ditch within a day or two following rains, (2) to prevent the formation of any ponds, pools or puddles from remaining more than a day or two following rains, and (3) to remove all water from the area to be protected within seven days following a rain.

2. The purpose of such work here in Louisiana is usually different on account of the difficulty of completely achieving the aims. The practical purpose is usually: (1) To achieve the aim so far as practical and economical, (2) to reduce breeding areas to such a condition that other control measures will be effective and financially feasible.

Anti-mosquito drainage may be accomplished by means of surface ditches of either the unlined, lined, or rock filled type, or by subsurface tile drains.

In planning a drainage system, consideration should be given to the probable period during which the ditches will contain water and to the best location of the ditches or tile lines with regard to grade and the type of soil. Careful planning for,and supervision of, the construction of a drainage system will increase its effectiveness and reduce the cost of maintenance.

In many instances it will be found desirable to make a map or sketch of the area to be drained,showing the location and available grade of at least the main ditches or subsurface drains.

Open Ditches: In order to prevent mosquito breeding in the water in ditches, open ditches should be so constructed that standing water will be completely removed and storm water drained from the surface of the ground and from the ditches within a short time after a storm. The grade and width of the ditches should be such that while all water will be carried away, the velocity will not be sufficient to produce "potholes" by erosion of the bottom or sides of unlined ditches. Such potholes may contain water long after the remainder of the ditch is dry and constitute prolific mosquito breeding places. A ditch that is too wide or too flat may likewise retain water in small depressions and thus defeat the purpose of drainage. Unless guarded against by frequent and careful inspection during construction, portions of the ditch will be excavated below or above the established grade, producing either low areas which will retain water when the rest of the ditch is dry or high sections which will prevent complete drainage.

Only a sufficient number of ditches should be dug to accomplish the desired purpose, that is the removal of standing water or the prompt elimination of storm water. Too few ditches will fail to attain these objectives while too many will increase the cost of construction and maintenance.

Generally all ditches should be constructed with narrow bottoms, smooth sloping sides, with as few curves as possible, and without sharp turns. Usually the sides of the ditches should have a slope of about 45° although in soft mud or sand the slope should be flatter, while in rock or clay the sides may be nearly perpendicular. If ditches are built at an angle to the slope of a hill, the upper side should be somewhat flatter than the lower in order to lessen erosion. The bottom of all ditches should be U-shaped, not V-shaped, and in the case of wide ditches the bottom should slope toward the center even if the sides are vertical. As far as practical, all vegetation which would shelter the adult mosquito should be removed from the edges of the ditches.

The main ditch should be constructed first and laterals installed only when and where they are necessary. At times it may be expedient to wait until after a storm or heavy shower to determine the number and location of additional or lateral ditches. A lateral or branch ditch should join the main ditch at an acute angle or gentle curve in order to avoid the deposition of debris or silt at the junction, or to prevent erosion of the opposite bank and the formation of holes in which water will be retained.

Care should be exercised that the dirt thrown out in digging the ditch does not form spoil banks which, by preventing the drainage of surface water into the ditch, will create pools and puddles in which mosquitoes will breed. Where the ditch runs transversely to the slope of the ground, the excavated dirt should be placed on the downhill side. Where necessary spoil banks should be levelled or the dirt disposed of elsewhere.

Where the ditch goes through a culvert or wherever a pipe section is installed, the grade should be increased to prevent interference with the flow by deposits of debris. At the

downstream end of the pipe or culvert, the bottom of the ditch should be lined with stone or concrete for a distance sufficient to prevent erosion and the formation of a hole in the bottom of the ditch. The upper end of the pipe or culvert may, if necessary, be screened with iron rods or a wooden grating to prevent the entrance of large pieces of debris or floatage.

Dynamite may be used to an advantage in wet ground in the construction of large ditches of considerable length where there is sufficient fall and volume of flow to permit irregularities in grade. This method is most suitable for ditching swamps and marshes where the soil is water soaked and where there are many surface and subsurface obstructions, such as roots and brush.

Dynamite cartridges are placed in holes made in the ground with an iron bar or a wooden pole. The size of the dynamite charge and the spacing and depth of the holes depend upon the width and depth of the ditch and the nature of the ground, and are usually determined by trial shots. In the construction of the ordinary ditch the charges are placed about 24 inches apart and at a depth of about 24 inches. Usually a section 100 or more feet in length is excavated at one firing. It is usually necessary to smooth the walls and bottom sufficiently to remove the high and low spots which would cause the formation of pools.

Ditch digging with dynamite, where practicable, is rapid and economical, and has the further advantage that the dirt which would otherwise form spoil banks is distributed over the terrain. It is not a feasible method for use in dry soils or in the construction of small ditches or those which must be carefully graded.

Lined Ditches: Where an open dirt ditch is in loose soil or where the flow in such a ditch reaches a high velocity, the bottom and sides may be rapidly eroded, increasing the difficulty and cost of maintenance and decreasing the effectiveness of the ditch in preventing mosquito breeding. Under these circumstances it may be found advisable to line the ditch with some impervious material for the purpose of preventing erosion of the sides and bottom or caving of the banks. A well constructed lining also facilitates cleaning.

Ditches may be lined with concrete or with stones laid in mortar, preferably cement mortar. Usually a lining which covers the bottom and extends up the sides to about three inches above the normal water line will suffice and it is not necessary to extend the lining to the top of the ditch walls. At other times, only the curves, turns, and junctions need be lined. At sharp curves the lining of the outer wall should be raised high enough to prevent scouring by an overflow of storm water. Also where the current from a branch ditch strikes the opposite side of the main ditch, the ditch lining may be raised or a splash wall installed to prevent erosion of the earth and the formation of potholes.

If stones are used for lining, fairly large flat stones should be selected for this purpose. The interspaces should be filled with smaller pieces and the whole sealed with cement mortar. Continuous concrete lining may be constructed by the use of forms. Where the ditches are less than 2 feet in width the concrete lining should be about 2 inches thick and reinforced with 2 inch mesh, hexagonal poultry wire. Wider ditches should have proportionately thicker walls. The concrete may be mixed with gravel or small stones and a smooth finish is not necessary. Seepage holes of suitable size should be made in the lining wherever it is probable that water will accumulate or flow behind the lining. The seepage holes should be directed downward and inward through the lining toward the bottom of the ditch and where concrete is used for lining they should be made before the concrete hardens.

Precast, sectional concrete lining may be used in lieu of the continuous lining. The sections are hemicylindrical in shape and usually from 30 to 36 inches long and from 12 to 16 inches in diamater. The sections may be joined by interlocking male and female ends or the bell and socket union may be employed.

The sectional lining gives better service than the continuous lining and is much cheaper where the ditching project is sufficiently extensive to justify the installation of a plant for manufacture of the sections. Sectional linings have the further advantage that if for any reason a ditch is no longer required, the sections can be salvaged and used in the construction of other ditches.

Ditches which are to be lined with either sectional or continuous concrete lining should be carefully graded.

Maintenance of Ditches: All ditches should be cared for in such a way that they will not constitute breeding places for mosquitoes. In the temperate zone they should be repaired in the spring of the year before the first mosquitoes appear and maintained in good condition throughout the summer months. In the tropics maintenance work must usually be continued throughout the year.

Any conditions which cause the formation of pools or puddles or which retard the flow of water should be corrected. This is accomplished by keeping the banks smooth and in proper alignment, by removing all obstruction to the flow, such as debris or accumulations of silt and mud, and by maintaining the proper grade.

The growth of algae in ditch water, especially in large ditches, may be sufficient to provide shelter for larvae. Algae can usually be destroyed by the application of copper sulphate at the rate of one part per million (about 8 pounds of copper sulphate to one million gallons of water). This quantity of copper sulphate will kill many fish and should not be used if it is desired that fish be preserved.

As far as practicable all vegetation should be removed from the ditch and from its banks. The loose debris and algae may be removed from either concrete lined or small earth ditches by dragging a heavy oil soaked ball or mop made of old rope or sacking along the ditch channel. Mosquito larvae are deprived of shelter and the mop leaves a film of oil on the water and the sides of the ditch.

Subsurface drainage: Subsurface or subsoil drainage lines consisting of covered tiles or rock filled ditches may be used to drain away surface water as it is absorbed into the ground, to lower the level of the ground water so that the soil will more readily absorb the surface water, or to intercept seepage planes and prevent seepage water from forming pools on the surface of the ground.

Tile drainage: The tiling used varies in size from 3 to 12 inches, usually from 4 to 6 inches in diameter. The lines are laid in the general direction of the grade and from 50 to 150 feet apart. The average depth of the tiling is from 2 to 4 inches below the surface, but the depth at which the tile is laid and the distance between lines will vary according to the topography and other local conditions. The closer a subsurface drain is to the surface of the ground, the more rapidly it will drain away the surface water and the smaller the area which it will drain.

The tiles are laid in the bottom of a carefully graded trench the slope of which should be not less than 3 inches per 100 feet. The trench is back filled and the tiling covered with earth, gravel or graded rock. Gravel or graded rock filling facilitates the rapid removal of storm water. If graded rock is used, the larger sizes are placed in the bottom of the ditch around the tiles and the finer grades at the top. The filling should be carried to a height of several inches above the level of the ground.

Rock filled ditches without tiling: Subsurface drainage may be accomplished by trenches back filled with graded rock, or relatively large stones, but without tiling. The trenches are usually dug from 12 to 24 inches in depth and the width of the spade or shovel used in digging. The rock used for filling should be from 2 to 6 inches in diameter and, if graded, the larger sizes should be placed on the bottom.

Rock filled ditches of this type are suitable for draining away slowly accumulating collections of water such as are found in spring fed marshes. Cost of maintenance is low as the rock filling prevents erosion and caving of the ditch walls.

Double decker drains: The so-called "double decker" drain is now being used in Panama and has proven of value in draining areas where there is a flow of water at all times but where the volume of water during the wet season is too great to be carried by the ordinary tile drains. The double decker drain consists of a ditch on the bottom of which 6 or 8 inch tile is laid in the usual manner. Instead of completely back-filling the ditch, ordinary sectional, concrete ditch linings are laid on top of or immediately above the tiling. The dry weather flow is carried by the tile line while the wet weather flow is drained away through both the tile line and the super-imposed open, concrete lined ditch.

Intercepting drains: Occasionally subsurface tile lines are installed for the purpose of intercepting the flow of seepage water. Seepage water is ground water (spring water) which is forced to the surface of the ground by the position of the underlying impervious stratum. Seepage areas usually occur on the side of a hill but may be found in other localities. The seepage water usually collects in small pools or puddles or produces a marshy area in which mosquitoes may breed in large numbers. An intercepting drain which consists of a tile line covered with graded rock is laid at approximately right angles to the direction of flow of the seepage water. It should be located above the point of the maximum flow of the seepage outcrop as determined by inspection during or soon after a heavy rain.

Maintenance of subsurface drains: Well constructed subsurface drains require but little attention, although occasional inspections should be made for clogging. It may be necessary to provide protection where traffic passes over a tile line. Ordinarily no cleaning or regrading is required.

3. Resume of principles of drainage to be followed:
   a. Drainage systems should be properly designed by mosquito control engineers to obtain maximum effect with minimum work at minimum cost.
   b. Grades must be used to best advantages and must be even to avoid formation of pockets or potholes.
   c. Cross-sections should be as narrow as possible consistent with necessary capacity, and sides should be properly sloped.
   d. Laterals should join main ditches at same level, at same grade, and at an acute angle.
   e. Culverts and pipes should be carefully laid to exact grade, and protected to avoid formation of potholes at ends.
   f. Excavated dirt should be spread or the spoil bank cut through to avoid ponding of water trying to enter the ditch.
   g. Cleaning, clearing and grubbing should be carried to a width necessary to permit proper construction of ditch and no wider.
   h. Concrete ditch lining is valuable in (1) preventing erosion in both sides and bottoms, (2) providing permanently and properly graded bottoms, and (3) greatly lowering maintenance costs. Design of such work should be by a mosquito control engineer, not by a sanitarian.
   i. Sufficient maintenance should be carried on so that at all times the work fulfills the

purpose. This is essentially the province of the sanitarian.

j. It is the small details which may mean success or failure: Meticulous attention to details is essential.

4. Filling: (a) Low areas may be entirely filled, or (b) filled to a level permitting drainage, (c) care as to methods and materials used is necessary. Ashes and cinders mixed with earth is preferable. Large fills may be made of earth and rock, but waste such as garbage, rubbish, sawdust may be utilized.

LARVICIDING

I. Larvicides to be used:

A. Phenol larvicides: There is growing question as to theharm phenol does to aquatic flora and fauna.

1. Use only those with phenol coefficient of 12.
2. For spraying use emulsion of 1 part larvicide to 25 parts water.
3. Apply in fine mist spray only (important).

B. Petroleum oils.

1. Mixture of (a) waste oil and kerosene, (b) crude oil and kerosene, or (c) ready purchased mosquito oil.
2. Test out each lot to ensure killing power.
3. May be applied in fine or coarse spray.
4. Rule: (a) oil the same place on the same day of each week, (b) oil near habitations about 24 to 72 hours after each rain, (c) make weekly counts in proper and adequate catching stations.

Oiling: When properly spread over the water, oil produces a film which kills mosquito larvae and pupae. The lethal effect of oil is probably due to the toxic action of volatile gasses after inspiration of the oil into the tracheal tubes. A highly volatile oil is highly toxic and a nonvolatile oil is nontoxic. Consequently the ability of an oil to kill larvae and pupae, and therefore its value as a larvicide, is proportionate to and determined largely by its volatility. A thick film of nontoxic oils may kill by suffocation but it is difficult to maintain such a film intact for a sufficient period of time.

Oil larvicides consist generally of crude oil or waste motor oil, either of which may be diluted with kerosene. Crude oil, or fuel oil, is larvicidal in its action but the heavier grades will not spread and produce a film on the surface of the water, especially during cool weather. Light crude oil which has a specific gravity of from 0.85 to 0.87 spreads readily and will form a satisfactory film in any temperature suitable for mosquito breeding. Kerosene may be used to dilute the heavier oils so that they will spread to form a film. The proportion of kerosene required varies from 20 to 75 percent, depending on the viscosity of the crude oil.

Kerosene alone may be used as a larvacide, but it evaporates rapidly. The film is fragile and easily broken, and it is usually too expensive for routine use.

Waste motor oil or other waste oils may be used as a base in lieu of the crude oil. Motor oil is relatively nonvolatile and is therefore nontoxic. It will kill larvae and pupae only when the film is sufficiently thick and intact to prevent them from reaching the air. As it is difficult to maintain such a film, the best results are obtained when the motor oil is mixed with and diluted by kerosene in the same manner as crude oil. The resulting product is apparently as efficient in the destruction of larvae as crude oil and where the waste oil is available, it is considerably cheaper.

As the larvae will develop in from a week to 10 days in warm weather, the oil should be applied at intervals of approximately one week. In colder weather, the period between oilings may be lengthened to possibly as much as 3 weeks. Various methods are available by which oil may be applied to the surface of water. The particular method selected will depend on the kind of water to be oiled, that is, small collections of standing water,ditch water, running streams, or large bodies of water such as ponds or lakes.

The quantity of oil required to produce a film over a given area depends to a very considerable extent on the viscosity of the oil and the amount of vegetation present. A film of toxic oil which is iridescent in the sunlight is thick enough to kill mosquito larvae. In quiet waters containing no vegetation or debris, one gallon of oil will usually produce a satisfactory film over an area of about 100 to 200 square yards (one quart for about 400 square feet). Where vegetation is present, the oil should be applied in such quantity and in such manner that the water around and under the vegetation will be covered as completely as practicable. In many instances it is extremely difficult to produce a satisfactory film where the oil must spread through vegetation.

In order to kill all the larvae, or at least the greater proportion of them, the film should remain unbroken for a period of several hours. The film may be washed away by currents, broken up by rain, or blown to one side by the wind; consequently, oil is ineffective as a larvicide if conditions are such that the film will not remain intact long enough to kill the larvae.

Oil may be effectively applied to small collections of water by means of an oil soaked broom, and oil mop or oil soaked cloths tied to a stick, or similar contrivances. The ordinary watering pot used for watering plants may be used to oil small collections of water

or the oil may be poured on the surface of the water.

Sprayers are usually employed in oiling larger bodies of water. Where continuous application is desired, continuous oilers of either the drip or submerged type are used.

Sprayers: The knapsack sprayer consists of an oil container, hand pump,and spray nozzle,and is carried and operated by one man. The ordinary sprayer has a capacity of about 5 gallons and a spraying range of about 25 feet. The knapsack sprayer is a practical and economical apparatus for applying oil to ditches, small ponds, or other collections of water which can be reached by the spray.

Larger sprayers may be employed to oil extensive areas such as the borders of large lakes or in some instances large swampy places. Such a sprayer usually consists of a barrel or tank container and a pump mounted on a vehicle or in a boat.

Continuous oilers: Where the oil is dispersed by currents, as in streams or ditches, a film can be maintained only by the constant application of oil. Either a drip or submerged oiler may be used for this purpose. Continuous oilers have many disadvantages and their use is feasible and practicable only in selected situations where a film cannot be economically maintained by other methods.

Drip oilers: The drip oiler consists of an oil container, such as a 5 gallon oil can or a small drum, which is placed on supports over the stream or ditch so that the oil will drip through an outlet onto the surface of the water below. The container should be placed several feet above the surface of the water so that the oil will spread quickly when the drops strike the water.

The rate of flow from a drip oiler may be regulated in one of several ways. The simplest regulator consists of a nail of suitable size passed through a perforation in the bottom of the can which is slightly larger than the diameter of the nail. The nail is wrapped with cotton, thin cloth or gauze and the wrapped portion wedged into the perforation. The flow can then be regulated by gently moving the nail up or down until the desired rate is attained. More elaborate regulators, consisting of stop cocks, faucets, pinch cocks, or flexible tubing or wicks, may be employed. However, any type of regulator requires attention to prevent interference with the flow by sediment in the oil and by changes in temperature.

In order to maintain a continuous film of oil on the runnning water, the required rate of flow will vary according to the width of the stream, the grade of oil, the spread attained, the velocity of current, the alignment of the stream or ditch, the roughness of the banks, the amount of algae in the water, floatage in the water, or weather conditions, and must be determined by trial in each case. Generally an average flow of from 10 to 20 drops per minute will suffice for each foot of width of the water in the stream or ditch. At times where the stream is sluggish, it may not be necessary to maintain a continuous flow and the the flow may be intermittently stopped or decreased.

Where supports for the drip oiler cannot be installed because of the width of the stream, flooding, or for other reasons, the oiler may be placed on a moored raft or float. The drip oiler can be used to the best advantage where it is desired to maintain a film on the water in indentations, eddies, and quiet places along the borders of a ditch or small stream. It may be used to apply oil to the surface of a stream so that it will be transported by the current to otherwise inaccessible pools formed by the stream or into which the stream empties. The drip oiler has the great disadvantage that it requires more or less constant attention and the flow is difficult to regulate and maintain.

Submerged oilers: A submerged oiler is a container having two small openings and so designed that when sunk to the bottom of the stream or pond the oil will escape through one opening and be replaced by water which enters through the other. The oil then rises to the surface and forms a film.

Submerged oilers have the disadvantage that they are difficult to adjust so that the oil will flow properly. A small outlet opening is easily clogged by sediment while a large opening tends to cause wastage of oil.

Oil-soaked sawdust: Oil may be applied continuously by means of a submerged bag of oil-soaked sawdust. A sack of suitable size is filled with sawdust and the whole soaked with oil larvicide. Stones or rocks are used to weight the bag. The oil will be given off gradually and maintain a film for a considerable period of time. A satisfactory film can be produced by scattering oil-soaked sawdust on the surface of the water in small ponds, puddles or hoof-prints.

Specification for Oils.

Oil or oil mixture furnished shall be homogeneous and shall not separate into fractions of different densities on prolonged standing, nor shall it deposit any solid or semisolid material on prolonged standing. It shall be free from granular, flocculent, fibrous, or other material which might cause clogging of spray nozzles. It shall not be subject to change or deterioration by oxidation or otherwise on prolonged standing in tanks or containers.

The oil furnished shall kill all the pupae and full grown larvae of mosquitoes in not to exceed one hour's time during which the oil is applied as a continuous film on clear water of normal dissolved oxygen content containing such pupae and larvae. Such test shall be made in a one quart glass mason jar containing ten larvae and five pupae immersed in one pint of water, uncovered and exposed in full sunlight. The killing time shall be determined

by the time after application of the oil (or oil mixture) when all larvae and pupae fail to respond by reflex muscular contractions or other activity to successive sharp blows struck on the side of the container by an ordinary lead pencil.
Specific grav'ty of oil 0.83-0.86, Viscosity 31-43, Initial boiling point 165°-230°C. Final boiling point Max. 800°F., Spreading coefficient 24.0 to 35.0. (1)
Such oil mixture shall be non-toxic to workmen spraying the material, shall not cause any dermatosis resulting from occasional contact with the skin in ordinary work, and in particular shall not cause any burning or irritation of mucous surfaces. It shall have no unpleasant or offensive odor. When applied in the field by means of a hand sprayer with Myers spray nozzle, it shall cover the water surface with a continuous stable film which shall persist as such for not less than two hours. The spreading coefficient of the oil mixture shall not be less than 24.0 or more than 35.0.

C. Pyrethrum larvicides:
   1. Intricate formulae and preparation difficult.
   2. Valuable for use in ornamental fish ponds.
D. Paris green
   1. Effective in bad conditions, but against Anophelines only. Efforts now being made to manufacture Parish greens that will be effective against other mosquitoes.
   2. Should be used only under supervision of an expert.

II. Timing:
   A. Seasonal: During the season when serious breeding occurs of the species of mosquito of which control is desired.
   B. Routine within the season.
      1. Against Anophelines, Culex, Aedes: The same place should be treated on the same day each week.
      2. Temporary puddles against Psorophora: Not less than 24 nor more than 72 hours after each rain.

III. The area to be larvicided:
   A. Against Anopheles, Culex, Aedes: All the territory within one mile of the area to be protected.
   B. Against Psorophora: Within 200 yards only of any habitations.

IV. The secret of successful larviciding:
   A. Effective larvicides and equipment.
   B. Meticulous attention to detail.
   C. Physically and mentally fit personnel.
   D. Ability to stick to routine except under emergency conditions, and then ability to vary in accordance with knowledge of species to be controlled and their habits.

SCREENING - MOSQUITO PROOFING

1. Always mosquito proof: Screening. All places by which mosquito could gain entrance must be blocked off.
2. Mosquito proof all possible openings of a house, including the porch.
3. Do not attempt to mosquito proof a house of such an unstable character that with reasonable care and use the mosquito proofing would not be lasting.
4. Use only good materials.
5. Provide for repeated revisits to train people to use and maintain mosquito proofing properly.
6. Do not undertake more of this work than can be handled properly within the available time.

NATURALISTIC (5)

Besides standard control method there are, however, quite a number of other methods of mosquito abatement, some of them relatively old and some relatively new, with which few health officers or sanitarians have been acquainted, and concerning which they should be informed if proper function as health advisors to communities is to be adequately maintained. The type of control measures referred to are described under the group designation of "naturalistic" methods. Mosquito breeding seems to be limited more by physical conditions such as available water, temperature and humidity, than by specific parasites which appreciably restrain the aquatic stages of mosquito development. It is true that there are numerous organisms which are predators on mosquito larvae, many kinds of fish, for example, being effective under certain conditions, but in general, under natural conditions, usually there is established a balance between predators and victims, and in the case of mosquitoes this balance is frequently at a level which permits a fairly large output of mosquitoes with an appreciable nuisance or disease-transmitting capacity. Therefore, in general, the control of mosquitoes by true parasites appears to be impossible, and control by predators is successful only under particular conditions and within fairly well defined limits.
But careful studies of mosquito biology have shown that many species of mosquitoes are very susceptible to changes in their environment, and slight changes in their environment, and slight changes in the breeding water may make it impossible for a particular species to

reproduce in significant numbers. Furthermore, in many instances it is possible to bring about slight but effectively unfavorable changes in environment by fairly simple methods which involve relatively small costs. Such simple environmental changes are termed "naturalistic" abatement methods, to distinguish them from purely biological methods such as the introduction of parasites or predators. The most general usage of the term "naturalistic" abatement would include also the more narrowly limited ideal of biological control.

Naturalistic abatement measures are not new, though their application has materially increased in the last few years. Stream bed flushing, for example, was used by Sir Ronald Ross at Ismalia, in 1903, and by J. A. LePrince at Panama in 1903. Dr. Henry Rost Carter of the U. S. Public Health Service as far back as 1914 saw the significance of the changes in water level in southern mill ponds due to the weekend shut down, in diminishing the breeding of Anopheles quadrimaculatus, and this observation has been the basis of one of the principal control methods used today against this mosquito in impounding reservoirs in the southeastern states. Naturalistic abatement measures have been used extensively in Malaya, Ceylon and India; for example, L. W. Hackett and his associates have developed their application in Europe; and in California W. B. Herms has for many years laid emphasis on the ecological phases of the problem, which emphasis is the basis of all naturalistic control.

For convenience, and to assist in the organization of thought on the subject, the naturalistic measures are classified into three categories - chemical, physical and biological, as follows: (1)

A. Chemical. (1) Changing the salt content of water - salinification and freshening. (2) Pollution.

B. Physical. (1) Silting. (2) Muddying. (3) Intermittent drying. (4) Constant level flooding with circulation. (5) Fluctuating water levels. (6) Controlled reflooding and redraining. (7) Flushing or sluicing. (8) Changes in sunlight - shading and clearing.

C. Biological. (1) Introduction of natural enemies (parasites and predators). (2) Changing flora and fauna to competitive or unsuitable types. (3) Elimination or destruction of aquatic food supplies.

Some examples of naturalistic mosquito control:

At Durazzo, Albania, the most effective malaria vector in the mediterranean basin was markedly controlled, by salinifying the marshes with sea water, whereas in Italy malaria carrying mosquitoes were decreased by preventing salty water along coast from salinifying the coastal marshes, thereby keeping the water fresh.

More than 500 acres of salt marsh in Alameda county, California, have been eliminated as mosquito breeders by silting in the past 10 years.

In Solano county, California, extensive areas of marshes have been cleared of Aedes dorsalis breeding by from 7 to 10 cycles of flooding and rapid draining.

In the southern states many areas are successfully using the fluctuating water level in impounded water for control of Anopheles quadrimaculatus.

Successful naturalistic methods of mosquito abatement are not evolved overnight by some lucky guess or feat of imagination. Their development requires patient and often prolonged investigation of a mosquito species in relation to its environment, and they are usually the product of intense study by men trained along biological and especially ecological lines, or by professional men who have developed a marked biological and ecological slant in their thinking. There is no reason why both health officials and mosquito abatement people cannot train themselves to think along these lines. The result will be more effective control of both disease-vector and pest mosquitoes, and our health officers and sanitarians should familiarize themselves with the principles of these naturalistic methods, even though they need not be specialists in the details of their application.

IMPOUNDED WATER

1. Impounding of water usually creates ideal breeding places for Anophelines.
2. State law requires permit from state department of health before any construction work is started on any impounding. Sanitarians should see that this law is known and obeyed.
3. Sanitarians should see that recommendations of state department of health are carried out, and especially that proper maintenance work is carried out as provided by the state law.
4. Control of impounded waters is technical. Sanitarians should not attempt it themselves, but should seek advice of state department of health experts and rigidly follow their recommendations.

AEDES AEGYPI CONTROL

1. Is solely the control of breeding in artificial containers in immediate proximity to houses.
2. Adequate premise inspection service essential. (a) Must be painstaking and thorough. (b) All containers must be found and controlled. (c) Repeated reinspections must be made to keep control of containers.

DESTROYING ENGORGED ANOPHELES AS A MALARIA CONTROL MEASURE.

Temporary emergency measures are not as satisfactory as permanent mosquito eradicative measures; yet at times they are an excellent substitute and can often be made of decided importance in opening up new territory, in engineering construction operations, in colonization, in developing agricultural lands in malarial territory, and in naval and military campaigns. A large economic loss is continually going on for the lack of their application.

Where a large portion of the population are new arrivals and come from nonmalarious territory and mix freely with the malaria carriers in the presence of Anopheles, an emergency situation may arise. In very few similar situations are precautionary operations against Anopheles production undertaken sufficiently far in advance. They certainly were not at the Panama Canal, nor more recently when we located our military cantonments in the most malarious sections of the South.

A close study of the problem has shown that a knowledge of the habits common to many Anopheles may be used to advantage by sanitarians in practical malaria control. The following are some of the important points to be kept in mind:

1. After many species of Anopheles become engorged they rest on the wall or other suitable shaded resting place relatively close to where they obtained their blood meal, and it is not usual for them to fly for a considerable time after becoming engorged.
2. Those which have digested their blood meal and are ready for flight depart from their daytime resting place (house or inclosure) either (a) after dusk, or (b) soon after daylight.
3. In the screened building the Anopheles ready to depart collect on the window screens or screen doors during these periods, and with a little care and practice, practically all of them may be destroyed. This should be done at a definite hour each morning. While on the screens they appear to be more interested in escaping from the building than from the person who is destroying them.
4. The recently engorged Anopheles at rest on the walls of the building are relatively easy to destroy. If they are rather closely spaced, a chloroform bottle or a catching tube may be used to advantage for collecting them; but ordinarily the common fly swatter will be found of more practical use.
5. Light colored walls make the task an easier one. In relatively dark rooms a flash lamp or other suitable artificial light (not too bright) is an advantage in obtaining perfect results.

At the farm-tenant homes where the family has insufficient funds to protect themselves from malaria by making the home mosquito proof, it is know that considerable reduction in malaria transmission can be accomplished by systematically destroying the Anopheles that are to be found each morning resting on the walls of the bedrooms. This is effective where no attempt has been made to screen the building.

It is thought that its practical use and value to our farming population of malarial districts is sufficiently important to cause sanitarians to make it better known and more widely employed.

USE OF CATCHING STATIONS

I. For survey purposes.
   A. Establish many stations and visit frequently to determine
      1. All species of mosquitoes in the area.
      2. The species at different times of the year.
      3. Relative numbers.

II. For checking effectiveness of work.
   1. Select a number of stations not more than six or eight per square mile near important breeding areas and if possible between those areas and habitations.
   2. Do not neglect "biting" catching stations.
   3. Visit each and make counts of species and numbers once each week and keep a record.
   4. Use comparative species and numbers to determine locations of missed or unknown breeding places.

The extent of mosquito breeding in an area and the effectiveness of mosquito control measures may be determined by inspections of potential breeding areas for the presence of larvae and by investigations of the prevalence of adult mosquitoes.

Both measures are important. The first has been the one more generally used but there has been for some years past a growing realization of the importance of securing an index of the adult mosquito population.

The fact that mosquito breeding is taking place as indicated by the presence of larvae does not necessarily indicate that mosquito production of an appreciable degree is likewise taking place.

The density of breeding and the species breeding in a particular area may vary greatly during the breeding season. To get a reasonably complete picture of the extent and kind of mosquito breeding by inspections for larvae at all periods would be very difficult and expensive.

Control measures, to be effective, must be based on a knowledge of the habits of the particular mosquito which is to be controlled. Different species of mosquitoes vary greatly as to breeding habits, flight range and feeding habits; and also as to their importance as pests or carriers of disease.
As a preliminary to the planning of a control program, an analysis of the problem should be made. In addition to mapping the location of potential breeding places and planning for their elimination or control, a survey should be made to determine what kinds of mosquitoes are prevalent, and when; which of them are of sufficient importance to warrant the cost of control measures, when control should be started and when it may be stopped.
Only when there is a clear and definite knowledge of such factors is it possible to plan and conduct a control program that will give a maximum degree of control at a minimum cost.
Much pertinent information on these points can be obtained by looking for adult mosquitoes in places where they are likely to be found if present in the area. Such places are called "catching stations".

TYPES OF CATCHING STATIONS

The sort of places used as catching stations depends on local conditions. Among the most commonly used are dwellings, particularly in bedrooms and behind pictures or furniture; underneath houses; in culverts and under bridges; in barns and sheds where animals are kept; in hollow logs or trees; in privies; and in spots where the observer stands as bait. These last are called "biting stations".
The most important considerations in the selection of a catching station are: (1) The station should be easily accessible; (2) it should be easy to see and reach all surfaces where mosquitoes may rest; (3) the station should afford the resting mosquito shelter from rain, wind and direct sunlight; (4) it should be such as to attract mosquitoes so that if present in the neighborhood they will be found in such a place; and (5) of such a character that other similar places may be found in the area.
The inside of houses, or barracks, are often very important as catching stations but sometimes such places are not readily accessible. Frequently, the finding of large numbers of mosquitoes inside the house may indicate that breeding is taking place inside the house. This is especially true of Aedes aegypti.
For surveys, and for some research work, the under side of dwellings offers an important catching area. Anophelines have been seen on the under side of the fireplace of a Negro cabin so numerous in spots that the end of a pencil could not be touched to the slab without touching several mosquitoes. For routine work, however, such places are not sufficiently accessible; and thorough examination of such places is disagreeable, dirty and takes a lot of time.
Barns and sheds where animals are kept sometimes are good places; but, on the other hand, they have their disadvantages. If large, they may not afford sufficient protection, and also unless all surfaces are easily observed, there is an opportunity for considerable error in counting, since the mosquitoes frequently change position and are not evenly distributed.
In rural and suburban areas, it has been found that privies are the best type of catching station for the Anophelines and for some of the worst of the pest mosquitoes. They fulfill all the requirements and are particularly good, if old, not exposed to direct sunlight and well provided with cobwebs.
At army camps tents are good catching stations, and the area just over the folded door flaps are a favored resting spot.
Some of the worst pest mosquitoes, notably Psorophora and to some extent Mansonia perturbans, do not appear to frequent structures and are best taken at "biting" catching stations. By this it is meant taking a position near suspected breeding places, exposing part of the body as bait and catching the mosquito while she is biting.
The group of swampy woods Aedes are vicious biters and may be easily located in this manner. The stations must be quite close to breeding areas, as these species apparently do not normally fly far in any great numbers but will bite readily if disturbed during the day. Aedes aegypti may also be caught at biting stations during the day. For most types, however, and particularly for Anophelines, the best catches are made at dusk as this is the time they move from breeding areas or daytime resting places to their nightly feeding grounds. Where possible the direction of flight should be noted.
Concrete culverts about three feet square in cross-section are very common and have proved to be good catching stations, particularly for the genus Uranotaenia. The under side of concrete bridges, particularly the space near the end, is also good, and in some sections seems to be favorite place for the genus Theobaldia. An advantage of concrete surfaces is that mosquitoes are easily spotted.
In the following paragraphs, the more common mosquitoes of Louisiana are arranged into three groups, based on their importance both as pests and as disease carriers, and the type of catching station where they are most likely to be found is also listed.

Group I. Of Widespread Economic Importance

1. Anopheles quadrimaculatus:	Privy catching station
2. Culex quinquefasciatus	Privy catching station
3. Aedes aegypti	Biting catching station
4. Psorophora columbiae	Catching station, tents
5. Aedes sollicitans	Near salt marsh areas only Biting catching station
6. Aedes taeniorynchus	Near salt marshes only Biting catching station

Group II. Often Economically Important Locally or over Considerable Areas

1. Anopheles crucians	Privy catching station
2. Culex salinarius	Privy catching station
3. Culex restuans	Privy catching station
4. Aedes triseriatus	Biting catching station
5. Aedes vexans	Biting catching station
6. Aedes atlanticus	Biting catching station
7. Aedes infirmatus	Biting catching station
8. Psorophora ciliata	Biting catching station
9. Psorophora cyanescens	Biting catching station
10. Psorophora ferox	Biting catching station

Group III. Only Occasionally Economically Important in Limited Areas

1. Anopheles punctipennis	Privy catching station
2. Culex nigripalpus	Privy catching station
3. Culex erraticus	Privy, culvert or almost any kind of structure catching station
4. Aedes dupreei	Biting catching station
5. Aedes bimaculatus	Biting catching station
6. Mansonia perturbans	Biting catching station
7. Uranotaenia lowi	Concrete culvert catching station
8. Uranotaenia sappharina	Concrete culvert catching station
9. Theobaldia inornata	Under concrete bridge catching station.

CATCHING STATIONS IN SURVEYS

There is a limitation to the use of catching stations that should be emphasized. The resting places used in cold weather by most of the Louisiana species are not those mentioned. In fact not much is known about the winter resting places of the most important Louisiana species. It is, therefore, not practicable to make a thorough mosquito survey in some sections during the winter. Surveys should be made in warm weather when adults will frequent the kind of places mentioned.

The density of breeding, the rate of production, and the species breeding in an area may change during the year. In order to get a reasonably accurate idea of the mosquito problem, it is necessary to take a census of the mosquito population several times during the year and to include all "samples" in the report of the survey.

The purpose of such a survey is to determine (1) the different species present in the area, (2) the location where each is found, (3) the prevalence of those important as pests and disease carriers, (4) the time when rate of production becomes important, and (5) the time when production stops or when the rate becomes low enough to warrant stopping control measures.

To secure such information a large number of catching stations should be selected. In each section of the area there should be different kinds of catching stations established and so chosen that any mosquitoes present are likely to be found in some of the stations. Care should be taken to locate catching stations near any suspected breeding areas and "biting stations" should not be neglected.

The question as to whether mosquitoes should be caught or merely counted is a moot one. In general, it will be found that with a little experience many of those found may be identified, to catch and add these to a collection would be a waste of time. Those which can not be thus identified should, by all means, be caught, identified in the field if possible, and if not, sent to an entomologist for identification. The purpose of the survey is to get information about all mosquitoes present, and this can not be obtained if any large number are left unaccounted for or unidentified.

A simple system of records should be kept. For the base record, a loose-leaf notebook is suggested, with a sheet for each station. A map of the area should be made showing the location of each catching station with a list of the species found in each. On this or another map may be shown the location of breeding areas, layout and schedule of drainage and oiling operations. A graph showing relative prevalence of different species at different times of the year will be found worthwhile.

CONTROL WORK

It is not necessary to await the result of a detailed survey before doing control work. An inspection of the area and a reconnaisance survey will locate many actual and potential breeding places. Control may be planned and started with these as a basis and the procedure amended and improved as the work proceeds and as indicated by the census of Imagos.

In routine control work catching stations serve another purpose. The objective here is not to determine the prevalence of all kinds of mosquitoes, but rather to check on the effectiveness of control measures by a rapid determination of the prevalence in each section of the area of a few troublesome species. The number, the location and the kind of catching station should be selected with this in mind.

Where special problems, such as control of the swampy woods Aedes, or the domestic Aedes aegypti, are being studied, it is necessary to establish a number of catching stations because of the short flight range of these species.

In most kinds of work the control of these short flight species is of minor importance. All of the most important species can be found if a comparatively few good catching stations are established and checked frequently, - weekly, if possible, but at least two or three times a month.

They should be located adjacent to houses near breeding areas, and then may be supplemented by biting stations nearer the suspected breeding areas of the short flight range species.

Once control work is in progress, the use of catching stations is almost a necessity. In general, control operations must be planned and conducted not to prevent completely the breeding of mosquitoes, but to prevent production. In places where drainage only is relied upon, it may be expected that a certain amount of breeding will take place, but unless this progresses to the stage of actual production, it is not important. However, it is very difficult to tell from merely observing the presence of larvae whether the place is actually producing adult mosquitoes. The use of catching stations will tell and will indicate when the condition of the ditch has developed to a point where maintenance is needed and whether supplemental larviciding operations are required to prevent an objectionable rate or production.

In oiling or larviciding programs, larvae may be expected to reach the fourth stage larva, or even the pupa stage, between oilings. It is frequently impossible to say with confidence, from larval observations alone, whether the next application prevents production, or whether some production may have occurred just previous to that oiling. The presence of adults, as shown by observations at catching stations will tell.

It is often very difficult to locate every single place in which breeding is taking place. No amount of checking on the condition of known breeding places will prevent production in a place the location of which is not known. Frequently the use of catching stations has indicated that such a place must be nearby and a more diligent search, which otherwise would not have been made, has located it.

Frequently breeding places develop or are created during the control period and are discovered through the use of catching stations. Sometimes mosquitoes find favorable conditions and may produce in numbers sufficient to discredit the control program and endanger popular and financial support before production is discovered unless catching stations are properly used.

This method provides a rapid and accurate means of checking the effectiveness of the control work. Thus these stations make it possible to cover more ground in checking work, without sacrificing efficiency.

MOSQUITO TRAPS

Sometimes it is desirable to make a collection of specimens of adults over a period of time. Traps are useful in this respect.

A very simple trap can be made on the principle of the old time rat trap with a screened box one side of which is made up of a cone of wire with a small opening into the center of the box. This screened box can be placed in any mosquito catching station with the cone on the bottom of the box. It can be hung in privies, under bridges and culverts and in similar places. The mosquitoes caught can be collected in the ordinary chloroform tube and preserved for study and classification.

Some investigators have used a more elaborate system incorporating a light to attract the mosquitoes and a fan to blow them into the cone of wire. The cone could empty into a small box or a screw cap bottle. The fan means that electricity must be available. The fan can be hung above the light while the cone is placed below the light. The insects attracted to the light are not broken by the fan but are blown into the cone and from there to the bottle. This method is selective in that only certain species are attracted to light. Changing the color and/or intensity of the light bulb may vary the types of mosquitoes caught. Very little published material is available on the use of traps in mosquito control work and the investigator should not hesitate to experiment with traps, bait, and methods of his own devising.

COLLECTION OF MOSQUITOES FOR IDENTIFICATION

Larvae, or wiggletails, are collected for breeding in aluminum bread pans measuring 10 by 15 inches by 3 inches deep, painted white inside with enamel. To remove larvae from dipper to vials or rearing jars, the ordinary medicine dropper with rubber bulb, but with the glass tip cut off to give a larger bore, may be used.

To obtain adult mosquitoes for identification,if wiggletails or pupae have been collected, the pupae should be separated from the larvae and placed in a pint fruit jar about half filled with the water in which they were found, and netting should be placed over the top of the jar. The wiggle tails should be kept in cups or shallow pans in the same water in which they were found, and, as they transform into pupae, they may be placed in the jar with other pupae. When a number of mosquitoes have emerged, they should be allowed to "harden" for 24 hours, and then a wad of cotton saturated with chloroform may be placed on the netting over the jar until the mosquitoes have dropped to the surface of the water. The jar is then rapidly emptied into a dish,the remaining pupae are transferred to fresh water, and the adult mosquitoes are picked up with tweezers and placed in a chloroform tube until dead. Tobacco smoke may be used to kill the adults if chloroform is not available.

CAPTURING ADULT MOSQUITOES FOR SPECIES IDENTIFICATION

In searching for adult mosquitoes for species determination, a few simple rules should be observed. Both male and female specimens should be collected. During the day few adult mosquitoes are active and so must be found in their hiding places. Generally most species will be found in dark, cool, and moist places, under bridges in rural areas, and under houses and in basements and cellars in towns. Within houses, the adults may usually be found hiding behind pictures, in draperies, closets, and the like. In rural areas, the outdoor privy is a favorite hiding place for mosquitoes. An electric flashlight is very useful in the search, as the light beam can be flashed along the ceiling and into the dark corners to locate the insects.

During the middle of the day, some species hide in shrubbery and usually can be found by shaking the bushes. Some species will attack humans during the day in the shade and require no special effort to locate.

<u>Simple devies:</u> A small net on a handle is useful in collecting specimens, but a small glass vial, straight-sided and without a lip, is usually all that is necessary. The vial can be slipped over the mosquito while at rest. The advantage of the glass vial is that less damage is apt to be done to the mosquito than if swept into a net. A cyanide bottle is a useful collecting device. This is made by pouring about one inch depth of wet plaster of Paris over a small quantity of sodium or potassium cyanide in the bottom of the vial and covering it with a circular disk of blotting paper. A similar vial using chloroform-saturated cotton is a substitute for the cyanide bottle. In grass, sweeping with a collecting net may be the only successful method for collecting specimens.

If it is desired to catch the mosquitoes and keep them alive, the sucking tube is the best device. This is made of a piece of three-quarter inch diameter glass tubing about one foot long, drawn abruptly down to a diameter of about one-fourth inch at one end. To this end attach about two feet of quarter-inch rubber tubing. Fit a piece of fine wire gauze into the small end of the glass tube to prevent specimens being sucked into the rubber tube. In operation, the open end of the rubber tube is inserted into the mouth, and the open end of the glass tube is placed near the mosquito; a sharp suck of the breath pulls the mosquito into the tube. The palm of the left hand should be quickly placed over the open end of the glass tube, and the mosquito examined and approximately identified. If it is to be kept, it can then be blown into a collecting bottle.

By the use of a chloroform tube adult mosquitoes may be captured while biting or resting on walls. Males, which do not bite, may be caught by sweeping the grass near their breeding places with a net. Adult mosquitoes should always be handled with tweezers and not fingers, since they are so fragile and the spots on their wings easily rub off.

A chloroform tube is made by placing a number of rubber bands, cut in small pieces, or a rubber stopper of proper diameter in the bottom of a test tube. The rubber is saturated with chloroform and a small piece of cotton placed on top of the rubber. Over the cotton is placed a disk of blotting paper. The tube should be kept tightly corked.

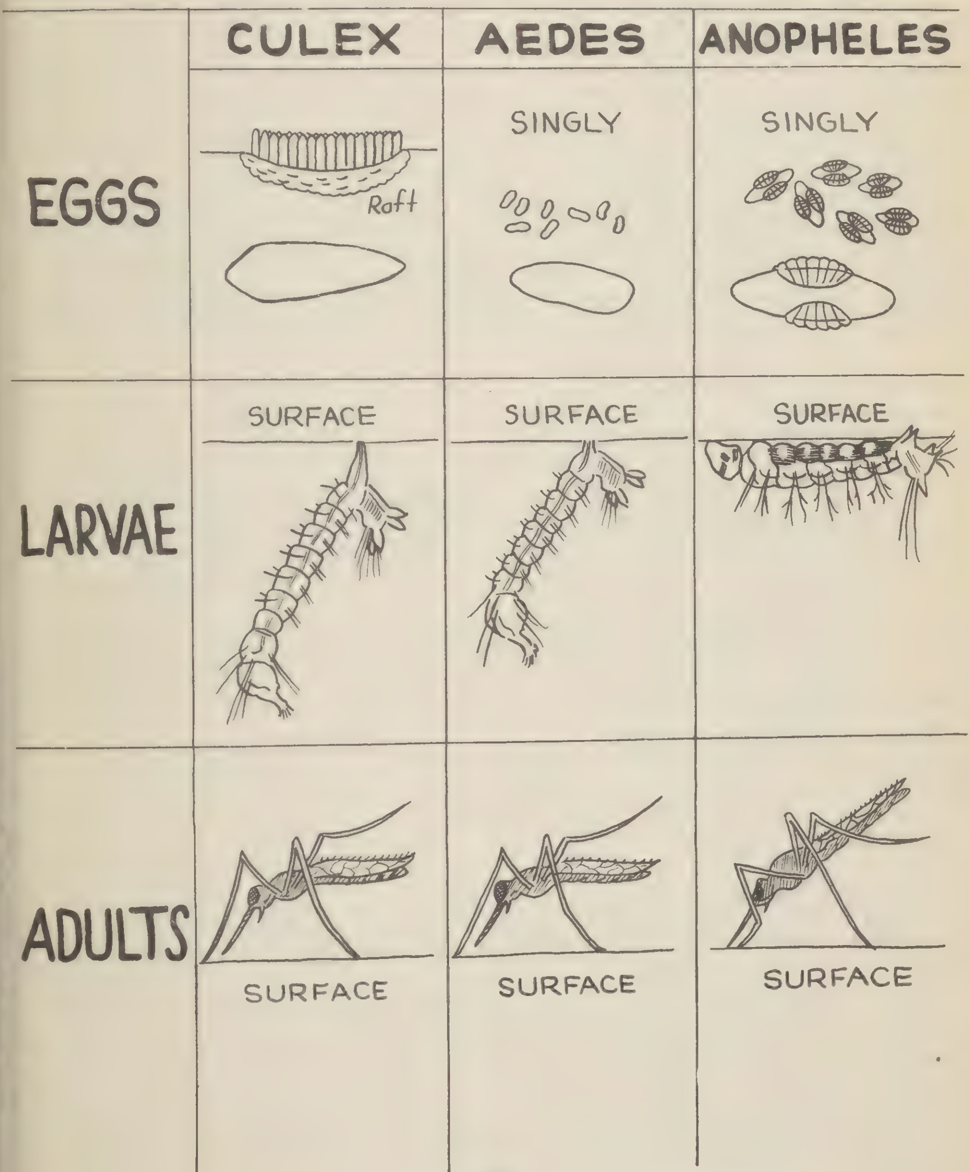
Larvae may be prepared for shipment for identification by placing them in small vials containing 70% alcohol or 10% commercial formalin, filled to the top with the liquid, so that no air-bubble is present.

Adult mosquitoes may be put between layers of tissue paper placed loosely in pill boxes, properly labelled. A wooden cigar box makes an excellent container for mailing.

HOW TO DISTINGUISH COMMON LOUISIANA MOSQUITOES

<table>
<tr><th></th><th>Anopheles Punctipennis</th><th>Anopheles Crocians</th><th>Anopheles Quadrimaculatus</th><th>Theobaldia Inornata</th><th>Culex Apicalis</th><th>Culex Quinquefasciatus</th><th>Culex Salinarius</th><th>Culex Restuans</th><th>Culex Erraticus</th><th>Psorophora Cyanescens</th><th>Aedes Aegypti</th><th>Aedes Atlanticus</th><th>Aedes Dupreei</th><th>Aedes Infirmatus</th><th>Aedes Thibaulti</th><th>Aedes Triseriatus</th><th>Aedes Canadensis</th><th>Aedes Vexans</th><th>Aedes Sollicitans</th><th>Aedes Taeniorhynchus</th><th>Psorophora Ciliata</th><th>Psorophora Howardi</th><th>Psorophora Columbiae</th><th>Psorophora Ferox</th><th>Psorophora Varipes</th><th>Mansonia Perturbans</th><th>Uranotaenia Sapphirina</th></tr>
<tr><td rowspan="2">ADULTS
Wing markings</td><td rowspan="2">An obvious yellow spot two-thirds way out on front edge of wing.</td><td rowspan="2">Wing yellow tipped; 3 black spots on rear short vein; black spots all over wings</td><td rowspan="2">Four black spots near center of wing; no black spots elsewhere. No yellow spots.</td><td colspan="24">Wings not obviously spotted</td></tr>
<tr><td>Wings unusually big</td><td colspan="14"></td><td>Some white scales on wings</td><td colspan="3"></td><td>Not spotted, but peppered black and white</td><td colspan="2"></td><td>Peppered black and white with very broad scales</td><td>Some of veins bright sapphire blue</td></tr>
<tr><td>Top of Thorax</td><td colspan="10" rowspan="2">Uniformly Colored.</td><td colspan="17">Definite pale markings on thorax, legs or both</td></tr>
<tr><td>Legs</td><td>Legs banded. Lyre-shaped pale markings on Thorax</td><td>Legs uniform. Narrow, pale longitudinal stripe entire length of Thorax</td><td>Legs uniform. Wide pale longitudinal stripe entire length Thorax</td><td>Legs uniform. Wide, pale longitudinal stripe from front 2/3 way back on Thorax</td><td>Legs Uniform. Bright golden spots on each side Thorax from front half-way back</td><td>Legs uniform. Middle of Thorax dark, sides brilliant silver</td><td colspan="2">Thorax uniform. Legs pale banded on both ends of joints.</td><td colspan="2">Thorax uniform. Legs banded on base end only.</td><td>Thorax narrow. Yellow stripe down middle. Legs pale banded, shaggy.</td><td>Thorax Uniform. Legs banded, shaggy at some joints only.</td><td>Thorax uniform. Legs banded.</td><td>Thorax uniform. Last two joints of hind legs all White.</td><td>Thorax dark in middle, white at sides; hind legs to next to last joint, white, last joint dark.</td><td>On head end of segments</td><td>On tail end of segments, Thorax with blue stripes.</td></tr>
<tr><td rowspan="2">Pale bands on top of Abdomen</td><td colspan="3" rowspan="2">Unimportant</td><td>On head end</td><td>On tail end</td><td colspan="4">On head end of segments</td><td rowspan="2">No definite bands, but heavily pale scaled all over segments</td><td rowspan="2">Pale bands on head end of segments</td><td colspan="5" rowspan="2">Usually none</td><td colspan="2" rowspan="2">On head end of segments</td><td rowspan="2">On head end of segments; also a longitudinal pale stripe.</td><td rowspan="2">On head end of segments</td><td colspan="5" rowspan="2">Scattered all over segments and on tail end of segments.</td><td rowspan="2">On head end of segments</td><td rowspan="2">On tail end of segments</td></tr>
<tr><td>Pale scales scattered all over segments.</td><td></td><td>Bands crescentic, not reaching side spots.</td><td>Bands of same width all the way across; may be wide or narrow; 7th segment all pale scaled</td><td>Bands tend to widen at sides, particularly on rear segments</td><td></td></tr>
<tr><td>Proboscis</td><td colspan="17">Not ringed—uniform in color</td><td>Ringed</td><td colspan="3">Proboscis pale ringed</td><td>Not ringed</td><td colspan="3">Pale Ringed</td><td>Pale Ringed</td><td>Not ringed</td></tr>
<tr><td>Color</td><td colspan="3">Blackish or Brownish Black</td><td colspan="5">Brownish</td><td>Black</td><td>Brilliant metallic Purple</td><td>Black</td><td colspan="3">Blackish</td><td>Black and Gold</td><td>Black and Silver</td><td>Brownish black</td><td>Blackish</td><td colspan="2">Black and Brown</td><td>Brown</td><td>Metallic Blue</td><td>Speckled Black and White</td><td colspan="2">Blackish</td><td>Brown</td><td>Brown and Blue</td></tr>
<tr><td>Size</td><td colspan="3">Medium to Large</td><td>Large</td><td>Medium to Small</td><td colspan="3">Medium</td><td>Small</td><td>Large</td><td>Medium to small</td><td>Medium</td><td>Medium to small</td><td>Medium</td><td>Medium to large</td><td>Medium to small</td><td colspan="2">Medium</td><td>Medium to large</td><td>Medium</td><td colspan="2">Giant</td><td colspan="2">Large</td><td>Large to medium</td><td>Medium to large</td><td>Small</td></tr>
<tr><td rowspan="2">Breeding places</td><td colspan="3">Clean, Stagnant Water, with Vegetation
Occasionally in running or dirty water</td><td rowspan="2">Woodland pools; occasionally polluted water even in cities</td><td rowspan="2">Pools with vegetation</td><td rowspan="2">Water with heavy organic pollution</td><td rowspan="2">Clean water; artificial containers; brackish water</td><td rowspan="2">Somewhat foul water; occasionally clean water</td><td rowspan="2">P ermanent pools with vegetation</td><td rowspan="2">Temporary pools and puddles near habitations</td><td rowspan="2">Clean water in artificial containers near habitations</td><td rowspan="2">Temporary and semi-permanent pools in wood or in open</td><td rowspan="2">Ground pools in woods</td><td rowspan="2">Ground pools in woods; occasionally tree holes</td><td rowspan="2">Water in stump holes or rotten stumps</td><td rowspan="2">Trees and log holes; artificial containers</td><td rowspan="2">Ground pools in woods</td><td rowspan="2">Woodland pools and swamps</td><td colspan="2" rowspan="2">Salt marshes or brackish pools</td><td colspan="2" rowspan="2">Temporary pools and puddles close to or remote from habitations</td><td rowspan="2">Temporary pools and puddles close to habitations</td><td colspan="2" rowspan="2">Temporary pools and puddles, usually in woods and not near habitations</td><td rowspan="2">Marshes and ponds with soft-rooted vegetation</td><td rowspan="2">Ponds and marshes; clean water with vegetation</td></tr>
<tr><td>Running water</td><td>Brackish water</td><td>Fresh water</td></tr>
<tr><td>Biting places, habits</td><td colspan="3">Worst at dusk, then until dawn; occasionally in daytime</td><td>If raised in clean water, unimportant. If raised in foul, may bite severely day and night</td><td>Does not bite humans</td><td colspan="3">Night or in shade in daytime</td><td>Night or occasionally daytime not severe</td><td>Night or day. An extremely severe and ferocious biter</td><td>Day or under lights; especially around ankles</td><td colspan="9">Severe day and night</td><td colspan="5">Ferocious and very severe biters day and night</td><td>Worst at dusk but very severe day and night</td><td>Bites occasionally only</td></tr>
<tr><td>Flight range</td><td colspan="3">About one mile</td><td colspan="5">Less than one mile</td><td>Not over one mile</td><td>Short; 200 yds.</td><td>Short; few hundred feet</td><td colspan="6">Short; not over a few hundred yards</td><td>Usually not over one mile</td><td colspan="2">Over 40 miles</td><td colspan="5">Short; 200 yards</td><td>Not definitely known; probably several miles</td><td>Not known</td></tr>
<tr><td>Position when biting</td><td colspan="3">Head and body in nearly straight line at distinct angle to Surface; "Stands on its Head."</td><td colspan="24">Body parallel to surface; "Sits down like a Fly"</td></tr>
<tr><td>Eggs Laid</td><td colspan="3">Singly on surface; boat-shaped with lateral air-chambers</td><td colspan="6">Regular rafts on surface</td><td>Dry depressions or mud</td><td colspan="7">Singly on damp or dry soil or on sides of containers</td><td colspan="3">Singly on damp or dry soil or on surface of water</td><td colspan="5">On mud or dry ground in depressions</td><td>Boat-shaped rafts on water surface</td><td>Irregular rafts on water surface</td></tr>
<tr><td>Palpi
Female</td><td colspan="3">Slender; long as Proboscis</td><td colspan="22">Less than half length of Proboscis</td><td colspan="2">Short</td></tr>
<tr><td>Male</td><td colspan="3">Long as Proboscis; clubbed</td><td colspan="5">As long as Proboscis</td><td colspan="17">Long and slender</td><td>Long</td><td>Short</td></tr>
<tr><td>LARVAE
Position to water surface</td><td colspan="3">Parallel to surface on surface; no breathing tube</td><td colspan="22">Head down at angle to surface; an obvious breathing tube</td><td>Does not come to surface; attached to plant roots</td><td>Parallel to but below surface; an obvious breathing tube</td></tr>
<tr><td>Feeding Habits</td><td colspan="3">Feed at surface</td><td colspan="22">Feed below surface</td><td>Feed at bottom</td><td>Feed below surface</td></tr>
<tr><td>PUPAE
Appearance</td><td colspan="25">Like fat Commas</td><td>Come to surface only for emergence</td><td>Like fat commas</td></tr>
</table>

HOW TO DISTINGUISH BETWEEN ANOPHELINES, AEDINES AND CULIEINES



IDENTIFICATION OF COMMON SPECIES OF MOSQUITOES

While the accompanying chart may be used as a key to the identification of the more important species of mosquitoes in Louisiana, it is rather more of a compendium of the various characteristics and habits of these mosquitoes.

Mosquitoes have been usually divided into two classes: one of which includes those species which have been definitely proven to be carriers of disease; and one which includes other species generally classed as nuisance or pest mosquitoes.

Recent investigations and studies carried on for the purpose of determining the means of transmission of a number of diseases, have placed very definitely under suspicion a number of species of the so-called "pest" mosquitoes.

For these reasons it is or may become necessary to recognize and control or eliminate the breeding of not only the known disease-carrying species of mosquitoes, but also other species which come in contact with man.

A most casual inspection of the accompanying chart will indicate the variation of physical characteristics and breeding habits of mosquitoes. It is, therefore, particularly necessary not only to recognize the species of mosquitoes with which one has to deal, but also their breeding places, habits, flight range, in order that proper and adequate methods of control may be applied.

In preparation of charts of this character, it is customary to group species of mosquitoes according to a definite characteristic.

As an example of how to use the chart for the identification of a mosquito caught biting, the following procedure would be used: Since the first grouping is based on wing markings, the specimen should be examined for markings on wings. Suppose that wings have no obvious markings. Since this group includes a number of species, one must look for further differentiation. The second grouping or sub-division is based on obvious markings on thorax, legs, or both. If the specimen has definite pale markings on thorax, legs, or both, it belongs in the second sub-group which may be further subdivided by location and character of markings. Further subdivision into species would be made by following down under the sub-group in which the specimen has been placed.

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(4) Economic Losses from Malaria - W. W. Fuchs

(5) Naturalistic Methods in Mosquito Abatement - H. G. Gray - California State Department of Public Health Weekly Bulletin. Jan. 18-25, 1941.

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(7) The Mosquitoes of the Southeastern States - W. V. King - U.S. Dept. of Agriculture Miscellaneous Pub. No. 336

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Rat Control

Rats were always considered a menace and were fought before their role as vectors of disease was understood. Because of the economic losses they caused to industry and commerce and the annoyance they created in homes, they were objects of hatred. Today, at least six diseases which are transmitted to man from the rat reservoir are known. Two of these; namely, plague and typhus, are transmitted to man from the rats by way of the rat flea; one, rat bite fever is transmitted by being bitten by the rat; another, icterohemorrhogic jaundice, is transmitted usually by contamination of water supplies by the excreta of rats; and still others food poisoning and tapeworm (hymenolepiasis) are transmitted by contamination of food by rat droppings. The rat also serves as a reservoir for trichinosis, but in this case the disease is transmitted to man indirectly through pigs that devour the carcasses of diseased rats. The whole story of the role of rats as carriers of disease to man is yet untold.

Rats cost the United States $200,000,000 every year. A rat eats and destroys $200 worth of food each year. They are the most destructive animals in the world. Rats have been responsible for more deaths among human beings than all the wars of mankind. Two rats could produce 359,000,000 decendents in 3 years, if conditions were favorable for them and no deaths occurred. They migrate freely from farm to farm and house to house.

The various methods of rat extermination which have in the past been employed are by natural enemies, fumigation, poisons, traps, and similar means. Some of these methods have proved satisfactory to a limited extent, but none have served with telling effect. The reason attributed to this failure is the belief that the fundamental and basic factor involved in effective rat control is the control of rat harborage, i.e., the enclosed spaces which afford rats hidden or partly hidden shelter, homes, and suitable facilities for breeding and protection of their young until maturity.

In order for a sanitarian to grasp the rationale of rat control it is imperative to study and understand the habits of rats. In order for any program of control to be effective, the techniques applied to rat control must be carried out continuously and must give more or less permanent results. The only technique which gives permanent results is "rat proofing". A rat control week campaign each year is as good as nothing.

The methods of rat control may be classified in several different ways.

A. The classification according to techniques used is as follows:
   1. Prevention or control of rat harborage by (a) rat proofing of buildings, (b) vent stoppage, (c) storage and removal of refuse.
   2. Destruction of rats by (a) trapping, (b) bait or fumigation poisoning, (c) natural enemies.

B. The classification according to permanency of results is as follows:
   1. Primary methods producing permanent results are (a) rat proofing of building, (b) vent stoppage.
   2. Secondary methods producing temporary results are (a) storage and removal of refuse, (b) trapping, (c) poisoning by bait or fumigation, (d) natural enemies.

Rat proofing of buildings. Technically, rat proofing is the application of four fundamental rules in construction and upkeep of building structures and their equipment: (1) Employing an approved rat proof design that fundamentally eliminates unnecessary enclosed spaces. (2) Using material of a rat proof character. (3) Employing approved rat proof methods of construction and installation. (4) Providing for periodic inspection of building and equipment to insure permanent upkeep.

Rat proofing is based on the knowledge of the habits of rats in choosing their habitats for reproduction and raising their young. There are three general types of rat harborage:
Structural. Examples of which are double walls, spaces between floors and ceilings, hollow tile partitions, enclosed stairways, hollow boxed moulding, raised platforms, and similar protected places.
Incidental. Examples of which are furniture and equipment, things that are incidental to the use that is made of a building or its subdivisions and are installed therein.
Temporary. Examples of which are mass storage of material or merchandise, rubbish heaps, old furniture, odds and ends piled in cellars, attics, and closets, and similar accumulations which if left undisturbed for periods of several weeks, can and will be used by rats for homes and breeding places.

Rat harborage is to be found in the great majority of buildings of the older type, and also in some buildings of modern construction, and in a great many styles of furniture and

equipment which are installed in mercantile and manufacturing establishments. In the majority of instances rat harborage exists because little or no consideration has been given by the owners, the architects, the builders, or the authorities to the desirability or necessity of providing for its elimination at the time the building was designed, planned, and constructed. As a result, man has provided and continued to provide rats with enclosed spaces ideally adopted for homemaking; and the same may be said of certain types of fixtures and equipment. In other words, man himself thoughtlessly establishes rat sanctuaries and gives the matter no further thought until the rodents become so plentiful that they must be killed off or reduced in numbers.

Rat proofing, then, depends upon (a) whether the rat harborage is to be prevented in the architects original planning of the building, (b) whether the buildings are old or new. This may determine the techniques to be used, (c) the cost of the project and the economic status of the community, (d) influence of public health authorities directing community efforts.

Rat proofing that is part of the conscious plan of the architect in designing the building remains an architectual problem in the hands of the architect. It remains for public health authorities to educate architects along these lines. The rat proofing of old or new buildings requires a good deal of thought on the part of the sanitary engineer. Usually new buildings lend themselves better to rat proofing since their materials are usually in better repair and are better preserved, and since it pays to spend more money on a newer building. Therefore, reconstruction is much more applicable to new buildings than to old buildings.

Vent stoppage. The cheapest possible method of rat proofing for older or old buildings is that of "vent stoppage", a method developed in Georgia for the control of typhus fever. It is not meant that this method should not be used on new buildings, but that more fundamental reconstruction should be encouraged for new buildings. Vent stoppage is the closing or protection of openings in the exterior walls of buildings, to prevent ingress or egress of rats. This method is only effective if applied to all adjoining buildings in a given area. The usual vents in buildings that require closing or protection are mainly ventilation openings, pipe and cable openings, deteriorated walls, and spaces around doors or windows that do not fit snugly.

The edges of doors should be protected against rat gnawing by 24 gauge galvanized sheet steel. Care should be taken to replace all decayed portions of doors and door facings before flashing in order to secure permanency of work. It is important that doors should be installed in open stairways and kept closed at night. Flashing front doors on a busy street is usually unnecessary because where such doors are installed to fit snugly, rats have rarely been found to gnaw through them.

Ventilator openings in foundation walls are often main points of entry into buildings for rats. To protect these openings properly, materials should be used that will be lasting in quality, such as perforated galvanized sheet steel of 14 gauge or heavier (galvanized after perforating) expanded metal of 18 gauge or heavier, or cast iron grills. Perforations or openings in the grill should never be larger than ½ inch. Many old buildings contain oversize ventilators and abandoned windows in the foundation walls. These should be partially closed with masonry and metal grills installed in the remaining opening.

To protect windows, especially those which are close to the ground, against rat entry and at the same time not reduce appreciably the amount of light passing through them 19 gauge galvanized wire cloth of ½ inch mesh should be used. The wire cloth should be installed for the entire height and width of the window.

Miscellaneous openings, like those through which pipes, cables, and drains pass, and those caused by the deterioration of walls should be sealed with brick, cement, metal, or concrete. Great care should be exercised in properly sealing or protecting abandoned sewers and drains leading into buildings.

In the case of buildings of wood frame construction in small towns and villages, vent stoppage is usually more expensive than for buildings constructed with masonry walls. The reason for this is that the space underneath the floor must be enclosed with a curtain wall of galvanized metal or masonry extending 24 inches below the surface of the ground, or the building must be elevated at least 18 inches above the ground surface. All other openings in wood frame buildings should be closed or protected in a manner similar to that for buildings having masonry or concrete walls.

Investigation and correction should not be forgotten in garages, chicken coops, and other out-buildings.

Before a rat proofing campaign is embarked upon, certain important steps should be taken:

1. PRELIMINARY SURVEY: (a) Epidemiological. Cases of typhus or plague should be studied as to location and spot maps prepared. Prevalence of rats and fleas according to species should be determined. (b) Engineering. Types of buildings and harborage, garbage conditions, nature of businesses in area and economic status of area should be determined. Estimates of the amount and costs of materials for each building and for entire program should be submitted to local officials.
2. METHOD OF FINANCING PROGRAM: Three methods are feasible. (a) Municipalities furnish labor and materials, (b) municipalities furnish labor and individual merchant furnishes material, (c) individual merchant furnishes all labor and material. The first method is best since it makes for uniformity of workmanship and shortest time for completion of work. The second method insures uniform workmanship, but delays completion of program. The third method induces non-uniformity of workmanship and delay in completion of program.
3. EDUCATION: All means of bringing the public health aspects of such a program to the people should be used. The population must be interested and willing to accept such work.
4. DEVELOPMENT OF GOVERNMENTAL SUPPORT: A well organized and respected health department should encourage the adoption of ordinances which would aid in carrying through the program and which would aid in preventing new conditions for rat harborage to develop.

The experience in Georgia indicates that the maximum cost per building for rat proofing was $100, and the minimum cost $15. The average cost per building was about $25. Their experience also showed that the average cost per business house for vent stoppage was less than $5.

Rat proofing of any type can never be successful until the general public is educated to its advantages, until schools and colleges teach its importance to architects and engineers, and until builders, contractors, plumbers, electricians and other building trades workers become conscious of its advantages.

STORAGE AND REMOVAL OF REFUSE:

It is well understood that rats will live close to where they can obtain food. Thus the storage of foods must be conducted in rat proof buildings and equipment. The storage of refuse, especially garbage, must be in accordance with the following procedure in order to be effective: (1) Garbage cans should be of heavy galvanized metal, water tight, tight fitting lids, easy for user to remove, and kept closed at all times. (2) Garbage cans should be big enough to hold garbage between collections. (3) They should be so arranged as not to be overturned by dogs or other animals. (4) There should be proper collection methods; and disposal methods should not be such as to encourage rat harborage. Incineration of garbage should be strived for. (5) Garbage ordinance should be enacted and enforced. Removal and proper storage of old lumber, boxes, rubbish heaps, trunks, piles of bricks, etc., should be carried on.

DESTRUCTION OF RATS:

Trapping. Trapping is a good secondary measure following up vent stoppage or other primary control measures. It helps to clear the building of rats after their harborage has been destroyed or after their exit from the building has been closed and it will also help to determine the effectiveness of the primary control measures.

Poisoning by bait or fumigation. Rat poisoning is also a good secondary method of rat control but is entirely too expensive and not effective as a permanent measure. This method should be used only as an immediate emergency procedure necessitated by typhus or plague outbreaks. It should be continued every 2 or 3 months until permanent control measures can be established.

There are two ways of poisoning rats, by bait and by fumigation. The latter method is reserved for boats mainly. For ship fumigation hydrogen cyanide (prussic acid gas) is almost universally used. It should be carried out by specialists, equipped with gas masks and proper life saving apparatus. Rat poisons used in bait are usually in the form of squills, phosphorus, arsenic, or barium carbonate. Red squill is the poison of choice because it is the only one which is extremely toxic to rats and yet harmless to human beings and pet animals.

Mistures of red squill bait depend entirely on the toxicity of the squill used. Red squill with a toxicity of 3 or 4 grains per pound of rat is mixed as follows: 1 part squill, 3 parts cornmeal or oatmeal, 12 parts meat or fish.

It is advisable to distribute two kinds of bait, meat and fish being most desirable. Bait prepared in the form of torpedoes renders most effective results. The torpedoes are made by placing about ½ teaspoonful of bait (about ½ ounce) in a paper napkin and twisting the ends. Colored napkins may be used to differentiate between the kinds of bait used. The effectiveness of torpedoes lies in the fact that they are small enough to be carried into rat harborages, resulting perhaps in the destruction of an entire nest.

The best kind of meat is fresh raw hamburgers and the cheapest bait is fish--canned salmon. The powdered red squill should be thoroughly mixed into each food, keeping the different kinds of bait separate. A little water may be added to moisten baits to aid in mixing. It is advisable before poisoning, to pre-bait with small amounts of unpoisoned food to see which the rats prefer. If torpedoes are not made from the bait, just distribute it by teaspoonful lumps on the floor or ground along the walls, runways and places where rats usually feed or frequent.

Enough bait should be used at one time for all rats on the premises. A thorough poisoning on one night is better than the frequent use of small amounts of poison. All the homes in the vicinity should carry on the poisoning on the same day; all food materials, garbage, etc., should, in so far as possible, be kept out of reach of rats for several nights before the campaign so the rats will be hungry on the night of the campaign. All pertinent facts related to the campaign should be published in the local newspaper and handbills should be distributed to homes as further guarantee that the people work in unison.

The business section should be treated by baiting squads. It takes 4 hours to 4 days, usually less than one day for red squill to kill rats. Premises should be searched for 3 or 4 days after poisoning and dead rats removed.

Through the experience of the rat poisoning work in Georgia, a method of estimating the cost of such projects for towns of less than 10,000 population has been worked out. A project for the business district of a town is estimated to utilize .05 pounds of bait per person living in the business district, while a project for city wide extermination of rats would utilize .25 pounds of bait per person in the population. In farming areas, .5 pounds of bait per person is generally used, while for an individual farm 2.5 pounds of bait per person living on the farm is required.

RAT POISONING CAMPAIGNS IN CITIES AND TOWNS as recommended by United States Department of the Interior, Bureau of Biological Survey.

The services of the U. S. Biological Survey are available to cities and towns in conducting cooperative rat poisoning campaigns by furnishing supervisory assistance in so far as funds permit and technical information without cost to the local agency. The local cooperating agency, such as town or country, will provide materials, equipment, labor, and local supervision.

In these campaigns all premises in the entire project area are to be visited and baited according to the need. The materials are mixed in a central place and put out in both the business and residential sections of town, with the consent of property owners, by crews working under competent supervision. Campaigns of this type provide an effective and safe means of reducing rat infestations over large areas at a relatively low cost. In addition to poisoning, the importance of rat proofing and removal of rat harbors is stressed, and information on such matters is furnished to all who are interested.

For each 1,000 population materials and labor are about as follows:

Powdered red squill (oven dried)....................13 pounds
Hamburger, ground fresh lean beef (unseasoned)......90 pounds
Oatmeal (regular)...................................45 pounds
Cornmeal..24 pounds

Miscellaneous: 2 large tubes, 4 market baskets, 1 pail, 2 pairs rubber gloves.
Labor: 10 men one day each.
Foremen: 2 men one day each.

A supervisor should be provided in towns of 2,000 population or over. Crews composed of a foreman and four laborers are recommended. One crew is needed in a town of 1,000 population and up to four crews for one of 10,000 population.

Note: Where labor is not available in the amount indicated, the bait for the residential properties is not put out by baiting squads but instead it is delivered in paper bags to a responsible person at each home with instructions for putting out the bait. Under this procedure 250 four pound bags and 500 one pound bags are required. The labor will be

about 4 men one day instead of 10, and two cars or light trucks with drivers and 4 to 6 boys of high school age for two to 3 hours in the afternoon for delivery of the bait.

Some local person should act as city leader to release publicity, purchase materials, obtain the help, and assist the supervisor during the campaigns.

TYPHUS FEVER AND PLAGUE

New world typhus fever and plague are transmitted to man by fleas of infected rats. The two most common species of rats in the United States are the brown rat (Rattus Norvegicus Erxlebin) or Norway rat, and the balck rat (Rattus Rattus Rattus). A less frequent rat found is the roof rat (Rattus Rattus Alexandrine) or Alexandrine rat. The brown rat is the more vicious and usually predominates where it is found. Because the same rats and same fleas are responsible for the transmission of both plague and typhus fever, the same methods of control are used.

The species of flea which carries these two diseases is named Xenopsylla Cheopis. A few other related species of fleas probably carry the disease to a much less extent.

In order to measure the potential danger of epidemics, arising from these two diseases, field workers have devised measuring rods to determine the quantity of fleas in general, and X. Cheopis in particular, that are present in rat populations. These measurements are:

Rat flea index: This index is the ratio of the number of rats to the number of fleas found on the rats or $\frac{\text{rats}}{\text{fleas}}$

X. Cheopis index: This index is the ratio of the number of rats to the number of X. Cheopis fleas found on the rats or $\frac{\text{rats}}{\text{X. Cheopis}}$

The critical X. Cheopis index is a X. Cheopis index of 1. It marks a X. Cheopis flea infestation among rats that indicates potential danger of plague spread if the rats happen to be infected. The greater the number of these fleas, the greater the potential danger of the spread of plague or typhus to man. It has been found that X. Cheopis index will be greater for rats caught in buildings, and that the X. Cheopis index will be too small to cause an epidemic of plague where rat harborage is outside of buildings. Evidently, rat harborage inside buildings is more suitable for the reproduction of the X. Cheopis flea. This indicates how important rat proofing of buildings is in control of plague and typhus. Not only are rats reservoirs of plague disease, but also many wild rodents have been found infected throughout the entire western United States.

Thus far, plague has been demonstrated in the following rodents: (1) Nine species of squirrels, (2) round tailed desert rats, (3) white tailed prairie dogs, (4) chipmunks (5) marmots, (6) wood rats.

Epizootics among the wild rodent life have been noted many times since 1900 when plague was first discovered in San Francisco. Plague among this wild life is called "sylvantic plague."

Although over fifty different species of fleas have been found in western rodents, only a few have been found to carry plague.

Besides being found on the rodents, fleas are also found in the immediate environment of these rodents. Fleas are not found where the rodent hosts are absent.

Predatory birds such as eagles and owls that feed on freshly dead infected rodents may play a part in the epidemiology of sylvantic plague by being incidental host of rodent fleas and by ejecting excreta with infected undigestible material.

Typhus is found in smaller towns and villages as compared to larger cities. It is more prevalent where the Norwegian species of rat is found. Where either the black or Alexandrine rats are found in large numbers the typhus incidence is low.

The flea indices from rats trapped in business districts of towns are higher than those from rats taken at residences.

References: Rat Harborage and Ratproofing - Public Health Reports
The Rat and Ratproof Construction of Buildings - Public Health Reports (Supp.)
Sanitary Inspector's Handbook - Clay
Preventive Medicine and Hygiene - Rosenau
Louisiana Sanitary Code

Rabies Control

Rabies or hydrophobia is a disease of warm-blooded animals including man. It is caused by a filterable virus which is usually introduced into the body by the bite of a rabid animal. The bite tears the tissues and allows the virus, which is present in the saliva, to enter the body. The virus travels along the nervous system and does not produce symptoms in the body till it reaches the brain; therefore, the closer the bite to the head the shorter the incubation period. The period of incubation in man is an average of about forty days. The old Pasteur method required an average of three weeks to complete treatment. At present, two weeks is all that is required. Usually it takes about three weeks after the last injection of the vaccine for the body to develop adequate immunity. Thus, if treatment is started immediately after the bite, the chances for preventing the disease are good. Rabies is a fatal disease.

The virus rapidly loses its strength when exposed to air and especially to sunlight, but if protected from heat, light, and air, it retains its virulence for a long time. For this reason, there is little danger of developing the disease from saliva-smeared fomites, but the possibility must never be forgotten.

Wolf bites are most dangerous on account of the savage character of the wound and the virulence of the virus. Cat bites come next, then dog bites, and then bites by foxes, jackals, pigs, asses, cattle, sheep and horses. There is no authentic instance of the transmission of the disease by the bite of man, though it is possible. The bites of horses and other herbivora are less dangerous because their blunt teeth usually cause contused wounds without effectively breaking the skin. Bites on exposed surfaces of the body are more dangerous than through clothing, since the saliva may be wiped from teeth while penetrating the clothing. The virus has been found in milk, but how important this may be in the transmission of the disease is unknown, since it is also known that gastric juice has a pronounced deleterious effect upon the virus.

Prevention of rabies is considered under three heads:

1. Treatment of the wound. The wound should immediately be treated by a physician.
2. The Pasteur prophylactic treatment. The patient should immediately be put under a physician's care, who will determine the course of this treatment.
   There is no contra-indication to treatment. Persons who apply for treatment of dog bites fall into seven categories.
   a. The dog is mad: in this case, treatment is begun at once.
   b. The dog shows suggestive symptoms:treatment is begun at once; discontinued if diagnosis is established as negative.
   c. The dog is not mad: observe the dog carefully for fourteen days, and if no symptoms develop, there is no danger of rabies in the bitten person. The treatment is then unnecessary. The dog may develop rabies after fourteen days and if it has been bitten by another dog should be kept under control for at least six months.
   d. The dog is not identified: treatment is advised except in regions known to be free from rabies.
   e. Exposure to saliva or milk: best policy is to give treatment.
   f. Contact with fomites: it is theoretically possible to get the disease in this manner, but not probable. The physician must decide whether treatment should be given.
   g. Psychoneurotic patients: this is the physician's problem.

The cost of the treatment of human beings is high and can too often not be financed by the average family. In Louisiana provisions are available whereby those families which can be certified by the welfare department as being unable to pay for the treatment, may receive the medication without cost, or if able to pay partially, may receive it for part-cost.

3. Control of rabies in dogs: Since this disease is preimarily a dog disease, it could be controlled in man if it could be controlled in dogs.
   a. Muzzling dogs: Consistent muzzling of all dogs for two years would practically exterminate rabies. This principle is gleaned from experience in England which showed that rabies diminished extensively two years after a muzzling law was passed and enforced. But the law was repealed later due to misguided sympathy for dogs and the disease reappeared. The law was again enforced, and in about two years rabies again disappeared.
   b. Quarantine: where adquate measures are being employed for control of rabies, a quarantine period of about six months should be enforced for all dogs brought into the country or community.
   c. Licensing and restraint: all dogs should be licensed and required to wear a tag, and under certain circumstances restrained by chain or leash. Stray dogs should be impounded and ownerless dogs killed. It is largely the stray dog that keeps rabies alive.

d. Education and responsibility: owners should be held legally responsible for damage inflicted by their dogs. Educational campaign for public is important.

e. Immunization of dogs: at present, a single dose vaccine is available for vaccination of dogs. The effectiveness of the vaccine is moderate and the immunity produced by it probably does not last more than a year,therefore, vaccination should be done annually. Vaccination alone is not effective as a measure of rabies control unless accompanied by licensing, quarantine, impounding, and destruction of stray dogs.

Immunization should be done by a veterinarian if possible. There are rural districts that are too poor to support a veterinarian, and in such a case, the vaccination can be done by the sanitarian under the supervision of the health officer.

The important factor in control of rabies is to have adequate legislation and to permanently set a means to implement the law. In large towns, this can easily be done by having enough finances to hire personnel such as veterinarians and dog catchers. In small communities this is difficult due to lack of money to finance such personnel. In the latter case it becomes necessary for close cooperation between the health department and the town or parish police authorities. By charging a nominal fee for vaccination of dogs, it sometimes becomes possible to finance a program in a small town or rural community.

Handling of dogs that have bitten persons or animals: such dogs should not be killed unless it is clear that they have symptoms of rabies, and then only if they cannot be apprehended with safety. It is important to know definitely whether the dog is mad. If the dog can be found and kept under observation for fourteen days and no symptoms appear, the Pasteur treatment is not necessary for the bitten person. The dog should be turned over to the proper authority for observation and study. If no means are available for such isolation in a public quarter, then the sanitarian should see that proper isolation of the dog is effected at the home of the owner, and regular visits are made by the sanitarian or health officer to ascertain the progress of the dog. Animals killed early in the course of rabies may fail to show miscroscopic evidence of the disease, thus causing delay in diagnosis and fatal mistakes. If killed, the head should be sent to a laboratory without delay and, if at a distance, it should be iced.

If it becomes necessary to kill the animal, it should be shot through the heart and not through the head. In amputation of the head, care should be taken not to injure the brain. The head should be amputated low enough to include part of the spinal cord. Rubber gloves should be used in this operation in order not to contaminate the hands with saliva or brain substance.

In packing the animal's head, it should first be placed in a tightly fitting metal container such as a one gallon friction top syrup can. This can should then be placed in another water-tight, covered, can which will allow sufficient space to add ice. No ice should be added to the can containing the head. If possible, both containers should be soldered to prevent leakage. A liquid solder is available which is satisfactory for this purpose. At the same time the head is shipped, a telegram should be sent to the laboratory informing it of the shipment. The package should be plainly marked and labelled "RUSH". The post office will handle such packages expeditiously for a special handling fee.

Reference: (1) Preventive Medicine and Hygiene - Rosenau

(2) Municipal and Rural Sanitation - Ehlers and Steel

Control of Communicable Diseases

The two most important factors in the causation of disease are poor nutrition and the spread of disease producing germs. The elaborate structure of modern medical science was not needed to prove that a sturdy body will resist the invasion of disease with greater fortitude than a weak body. This was known hundred of years ago when medical knowledge was merely an aggregate of superstitious formulae. That the consumption of good food is conducive to a sturdy body has no less been an age old fact. The elaborate and detailed knowledge of nutrition, as it exists today, has deepened understanding and whetted weapons in the struggle for a healthier human race, and it is continually confirming age-old ideas about health and nutrition. But the relation of germs to disease is a relatively recent acquisition to medical knowledge. This knowledge had its inception scarcely more than three score and ten years ago. And yet, despite the newness of this knowledge, sanitation in a crude form had been practiced for thousands of years. It was practiced because it appeared to work, even though it was not known why. But now that science has taught why, and because of that developed a fine technique in methods of sanitation, modern ability to control the spread of disease can be really effective. Now, with the science of nutrition and the science of germ control, years of life have been added to the population. But how many more years could be added to the life of the population if only the facilities were available to put into practice the present knowledge of disease control!

The whole principle of sanitation revolves around one general principle - the manipulation of environment in such a way as to reduce to a minimum those factors which cause stresses and strains on the individual and community, and to regulate human activity in such a manner as to prevent the spread of disease producing germs from one living organism to another. Therefore the various methods of sanitation depend upon the history of those factors which cause disease, or aid in the spread of disease. Thus, the history of the typhoid, cholera and dysentery germs teach that germs live in the intestinal tract of the human and pass out of the body with the contents of the bowel movement. For this reason a safe method for disposal of excreta is absolutely essential. It is further known that water may harbor these germs over long periods of time and is therefore an effective carrier of them from one place to another. For this reason a safe water supply is necessary. The prevention of pollution of streams, the restricted use of streams for swimming and other purposes that may bring the individual into contact with the contaminated water, the necessity for good plumbing, safe wells, and efficient water works - all these measures must be observed. It is known that these germs get on the hands of carriers, and therefore become a hazard when such a carrier is a food handler. Therefore all dairy workers and milk handlers should be under supervision, all soda fountain clerks, cafe waiters, fruit and grocery store employees and other food handlers, should be under strict scrutiny. It is also known that these germs may spread directly from one person to another. Therefore the isolation of the infected person is of paramount importance.

It is known that malaria, yellow fever and dengue fever are spread from person to person by way of very definite species of mosquitoes. If these particular kinds of mosquitoes could be controlled then so could the spread of these diseases. Therefore it is essential to drain swamps and ditches, to spray bodies of water, to devise methods for controlling the level of lakes and impounded waters, to facilitate drainage of refuse water from homes and factories, to screen homes, and take other precautionary measures.

It is known that tuberculosis, typhoid fever, scarlet fever, septic sore throat, dysentery, undulant fever and food poisoning are spread by milk and milk products. Therefore rigid control of the production of milk and milk products are essential to control their spread. Dairies must be supervised, cattle must be tested, dairymen must be examined, the production of ice cream and pastry must be vigilantly observed, and the distributors of these products, such as grocery clerks and waiters must be under continual observation.

It is known that hookworm disease spreads due to lack of sanitary excreta disposal. Therefore the building of privies or other types of safe toilet facilities are absolutely necessary to control the spread of this disease.

It is known that trichinosis and tapeworm are spread by consuming infected hog meat. It is therefore necessary to control the production of pork products such as weiners and hams and keep continual watch over those farms which raise hogs for public use. Humans who eat raw, partly raw, or poorly cooked hog meat that is infected with this germ will contract these diseases. Hogs which are fed the uncooked refuse material from slaughter houses or garbage containing infected particles of uncooked hog meat will contract trichinosis. The stools of humans infested with tapeworms must be carefully disposed of to prevent spread of this disease to cattle or pigs.

It is known also that human lice may carry typhus fever and trench fever, that the wood tick may carry rocky mountain spotted fever, that rat fleas may carry typhus fever and plague, that flies may carry a host of common diseases, that rabbits may carry rabbit fever(tularemia), that dogs and other domesticated animals may carry rabies, that horses may carry epidemic meningitis. The more that is learned about the history of diseases in insects and animals, the greater is the knowledge of the spread of diseases to man.

One of the most common means of spread of disease is indirect contact by way of dishes, towels, toilet seats, bed clothing, and the like. Therefore general care and cleanliness relative to those items is of utmost importance in control of many infectious diseases. Such diseases as the common cold, influenza, pneumonia, scarlet fever, septic sore throat, whooping cough, diphtheria, tuberculosis, typhoid fever, dysentery and mumps may be spread by unclean dishes. Towels and bed clothes may spread tuberculosis, typhoid fever, venereal diseases, measles, smallpox, chicken pox and a score of other infectious diseases.

It can be quickly gathered from all this, what a fundamental role sanitation plays in the control of diseases. It can also be seen what basic roles excreta disposal and water supply play, generally, in community sanitation. Rural schools and homes are generally handicapped by poor sanitation, usually due to poor economic conditions of rural communities, but gradual and persistent improvement is possible.

AVENUES OF TRANSMISSION OF COMMUNICABLE DISEASES

Cups, Spoons, Glasses, Dishes, Discharges of Nose & Throat & Droplets.

1. Mumps
2. Diphtheria
3. Scarlet Fever
4. Common Cold
5. Measles
6. Pneumonia
7. Influenza
8. Tuberculosis
9. Whooping Cough (Pertussis)
10. Vincents Angina
11. Meningococcus Meningitis
12. Infantile Paralysis (Poliomyelitis)
13. Septic Sore Throat
14. Typhoid Fever

Food

1. Cholera
2. Dysentery (amoebic & bacillary)
3. Paratyphoid & Typhoid Fever
4. Tuberculosis
5. Icterohemorrhagic Jaundice
6. Botulism
7. Food Infection & Poisoning

Sewage

1. Infantile Paralysis (poliomyelitis)
2. Dysentery (amoebic & bacillary)
3. Paratyphoid Fever & Typhoid Fever
4. Cholera
5. Icterohemorrhagic Jaundice (rat excreta)

Lice

1. Typhus Fever
2. Relapsing Fever

Flies

1. Anthrax
2. Cholera
3. Dysentery (amoebic & bacillary)
4. Paratyphoid Fever and Typhoid Fever
5. Tuberculosis
6. Tularemia

Milk

1. Diphtheria
2. Dysentery (bacillary)
3. Paratyphoid Fever
4. Infantile Paralysis (Poliomyelitis)
5. Scarlet Fever
6. Septic Sore Throat
7. Typhoid Fever
8. Undulant Fever
9. Food Poisoning

Water

1. Cholera
2. Dysentery (amoebic & bacillary)
3. Paratyphoid Fever
4. Typhoid Fever
5. Undulant Fever

Excreta

1. Hookworm (ancylostomiasis)
2. Anthrax (animal excreta)
3. Tuberculosis (human & bovine excreta)
4. Dysentery (bacillary & amoebic)
5. Typhoid Fever
6. Paratyphoid
7. Chlorea
8. Infantile Paralysis(poliomyelitis)
9. Icterohemorrhagic Jaundice (rat excreta)
10. Ascariasis
11. Pin Worms (oxyuriasis)
12. Whip Worm (trichuriasis)
13. Echinococciasis (sheep, cattle, hog & dog excreta)
14. Hymenolepiasis

Meat

1. Anthrax
2. Trichuriasis
3. Tuberculosis
4. Undulant Fever
5. Tularemia
6. Food Poisoning
7. Tape Worm

Mosquitoes
1. Anthrax, (mechanically transmitted)
2. Dengue (Aedes aegypti)
3. Malaria (Anopheles)
4. Yellow Fever (Aedes aegypti)

Fleas
1. Typhus Fever (rat & rodent fleas)
2. Plague (rat & rodent fleas)

Tick
1. Rocky Mountain Spotted Fever
2. Tularemia
3. Relapsing Fever

Rabbit
1. Tularemia

Fowl
1. Psitticosis

Hides, Wool, Fur
1. Anthrax

Grains, Grass, Cattle Fodder
1. Actinomycosis

Shellfish
1. Typhoid Fever
2. Paratyphoid Fever
3. Dysentery
4. Cholera

Dog
1. Rabies (bite)
2. Tapeworm
3. Canine Hookworm

Rats
1. Rat-bite Fever (bite)
2. Typhus Fever (rat flea)
3. Plague (rat flea)
4. Jaundice (icterohemorrhagic)
5. Tapeworm (hymenolepiasis) (rat & mice excreta)
6. Food Poisoning

Contact (direct or indirect)

1. Anthrax
2. Chickenpox
3. Cholera
4. Actinomycosis
5. Diphtheria
6. Dysentery (amoebic & bacillary)
7. Encephalitis
8. Measles
9. Glanders
10. Gonorrhea
11. Influenza
12. Leprosy
13. Meningococcic Meningitis
14. Mumps
15. Paratyphoid Fever
16. Plague (Pneumonic)
17. Pneumonia
18. Infantile Paralysis (Poliomyelitis)
19. Scarlet Fever
20. Septic Sore Throat
21. Smallpox
22. Syphilis
23. Trachoma
24. Tuberculosis
25. Typhoid Fever
26. Undulant (contact with animal)
27. Whooping Cough (pertussis)
28. Common Cold
29. Impetigo Contagiosa
30. Lymphogranuloma Inguinale
31. Ring Worm
32. Scabies
33. Vincents Angina

The control of communicable diseases has been in the past and is at present one of the most desired phases of human welfare. The struggle of society against its invisible enemies, the disease producing germs, has been one of the most tragic, most heroic and most glorious chapters in history. The toll of human life from communicable diseases has always been overwhelmingly greater than that of all the wars and accidents and other calamities that have devastated human society. From time immemorial these tales of horror have come down to us. Ancient history, Greek and Roman, is replete with stories of deaths. Medical history is no less a stark testimonial.

Knowledge of control of communicable disease has grown tremendously in the past fifty years. This has been mainly due to understanding the nature of disease producing germs, both from the points of view of how they spread and how they react in the body of animals and man. Through the understanding of how germs spread, people have learned how to prevent the spread of these germs. Understanding how they react in their host has taught how to counteract their reactions. The former knowledge has lead to effective sanitation and hygiene; the latter knowledge has led to methods of immunization and treatment.

Certain measures of sanitation and hygiene become imperative during abnormal circumstances, that is, in the presence of a threatening spread of disease:

NOTIFICATION

Whenever a communicable disease occurs in a community, the case should be immediately reported to the health department. The reporting of diseases is the usual duty of the family physician. But there are many instances when, due to circumstances, the physician fails to report such cases; then it becomes the duty of the intelligent and social minded people of the community to report such cases. Usually this function devolves upon the school teachers who are in constant contact with most families through the children. Measures for the control of spread of diseases can only be instituted by the health authorities when they are

informed of the existence of such diseases. It should never be forgotten that most children's diseases start as common colds. Thus the common cold becomes an immediate sign of danger to the rest of the children. Sore throats, slight fever and flushing of face, droopiness, headaches, lack of appetite, emaciation, pallor, puffiness of face, swelling of neck, shortness of breath, eruptions, coughs, vomiting, nasal discharges, are also signs of danger which must be heeded, since these may also be the first indications of serious communicable diseases.

INVESTIGATION

Investigation of a communicable disease can only proceed if notification is carried out. The importance of investigation by the health department becomes evident when the purpose of investigation is considered. The purpose is:(1) To detect the source from which the disease has spread, (2) to discover other possible cases of the disease, (3) to prevent the spread of the disease from the discovered source, (4) to do whatever possible to minimize the effects of the disease in persons already infected.

ISOLATION

Isolation has a distinct value in some communicable diseases and less value in others. The health authorities are the final judges as to how long, if any, isolation is to be affected. Isolation in a hospital is the preferred method, first of all because the patient will receive better and more expert care; secondly, because hospital isolation is much more effective than home isolation; and thirdly, because the rest of the family will not have to be quarantined for as long a time as when the patient was at home. The period of isolation depends upon the disease. Some diseases remain communicable for longer periods than other. The period of isolation is as long as the disease remains communicable. The periods of communicability of various common diseases are as follows: Chickenpox - till 10 days after the first appearance of the rash, diphtheria - 2 to 4 weeks, depending on how long the germ is found in the nose or throat, influenza - till patient appears completely recovered, measles - till a week after the first appearance of the rash, mumps - till the swelling disappears, pneumonia- till discharges from mouth and nose no longer carry the germ,poliomyelitis (infantile paralysis) about 2 weeks after onset, scarlet fever - till about 3 or 4 weeks after onset, depending on how long the germ is found in the throat, septice sore throat - till germs disappear from throat, syphilis - as long as open sores persist - usually first four years, unless patient is treated; smallpox - till scales and crusts disappear, tuberculosis - as long as patient discharges germs - period usually long, typhoid fever - till no more germs are found to be discharged, whooping cough - till about 3 weeks after the whoop first appears, depending on how long germs are discharged in the cough.

QUARANTINE

Those people who have been in contact with a communicable disease and may be in the process of developing it must be quarantined. It must be remembered that diseases do not immediately show themselves when a person is infected. It takes a certain number of days for the disease to develop in the body before the actual signs of the disease become manifest. The period of silent development is called the <u>period of incubation</u>. The period of quarantine depends upon whether those who are to be quarantined remain in constant contact with the patient or whether they remain completely isolated from the patient. If they remain isolated from the patient they should be quarantined only for as long as the incubation period may be. If they remain in constant contact with the patient they must be quarantined for a period equal to the length of time that the patient may still communicate the disease plus the period of incubation.

The periods of incubation of the common disease are: Chickenpox - 2 to 3 weeks, diptheria 2 to 5 days, gonorrhea - 1 to 8 days, influenza - 1 to 3 days, measles - 10 to 18 days, mumps - about 21 days, pneumonia - 1 to 3 days, poliomyelitis (infantile paralysis) 7 to 14 days, rabies - 2 to 6 weeks, scarlet fever - 2 to 7 days, septic sore throat - 1 to 3 days, smallpox - 8 to 21 days, syphilis - 2 to 6 weeks, tuberculosis - variable, typhoid fever - 7 to 14 days, whooping cough - 7 to 10 days.

Consider an example to make this entirely clear. Suppose Jimmy developed measles, but his sister Jane did not appear to have it. The period of incubation of measles is 10 to 18 days. This means that Jimmy had the measles 10 to 18 days before it was apparent that he was sick. Therefore Jane who was in contact with him during this period may also have contracted the measles during this silent period. The problem that now presents itself, is how long is Jane to be kept away from school and away from any other children. If Jane is immediately isolated where she is no longer able to contact Jimmy, she should be quarantined for 10 to 18 days, because who knows but that she may be in the period of silent development of the disease. But suppose that Jane remains at home and in constant contact with Jimmy? In such a case she will have to be quarantined for a longer time for Jimmy will be

able to communicate the disease to her for about a week after his rash first appeared. Therefore, Jane will have to remain quarantined during that whole week and also for 10 to 18 days after that week. But Jimmy himself will need to be quarantined for only one week after the rash appeared on him. Yet it would not be wise for Jimmy to go to school so soon for fear that he might develop some other complications such as pneumonia due to unduly exposing himself to the weather too soon.

The period of incubation of the common cold is very short, evidently one day or less. The period during which it remains communicable after its signs are manifest, is about 2 or 3 days. It is very important to pay a great deal of attention to the common cold. On the one hand, it spreads very readily and may produce epidemics with great swiftness. On the other hand, the complications of this disease among the undernourished and poorly cared for children are very dangerous. The most frequent complications are ear and sinus infections which may lead to mastoid trouble and pneumonia which are very dangerous. The greatest danger of this disease or any of the childhood diseases is in bringing them home to a household where there are small children. The death rate from most of these diseases among infants and small children is always very much greater than among older children or adults.

PLACARDING

Placarding the home where a communicable disease exists has limited value. It makes the neighbors careful of those homes where the inmates are careless and uncooperative. It penalizes those who are admittedly recalcitrant to advice. Placarding is unnecessary for homes whose dwellers are socially minded and cooperative.

DISINFECTION

Disinfection of all the excretions of the patient is an important procedure, since many diseases are spread through the excretions: therefore careful disposal of them must be carried out. After the patient is no more in the communicable stage, it is necessary to clean the room and all that is in it. This is best done with soap and water and sunshine. Fumigation is valueless except in rat control and has no place ordinarily in the control of communicable diseases.

Disinfection of body excretions and disease soiled linens is a very practical public health procedure. At least 2 hours contact should be provided for all disinfectants of body excretions. Body discharges should be caught in impervious vessels and immediately treated with disinfectants and covered to prevent access of insects. Where there is disease of the intestinal tract the feces and urine should be disinfected. Feces should be broken up with a stick to allow access of the disinfectant to all parts.

Disinfectants:

1. Lime - hydrated lime when mixed with 4 times its volume of water forms milk of lime. Equal bulks of milk of lime and feces will disinfect the feces.
2. Chlorinated lime - 6 ounces of chlorinated lime to a gallon of water makes a standard solution. This is used for disinfecting excreta, floors, etc.
3. Carbolic acid - used in solutions of 2 to 5% as disinfectant, for sputum, feces, linens, dishes, barns, stables, etc.
4. Formalin - this is used in 10% solution as an effective disinfectant.
5. Bichloride of mercury - used in solutions of 1:500 to 1:1,000 as feces and linen disinfectant.
6. Alcohol - this is a good antiseptic at solutions of around 70%.
7. Pine oil - it is an effective disinfectant for feces in 1:500 solution.
8. Sulphuric acid - this is used in 1:1000 solution as disinfectant.

CARRIERS

The control of carriers of diseases has always been a difficult problem. By a carrier is meant a person who carries any of the infectious germs but who is not sick and does not show any of the signs or symptoms of the disease. The two types of carriers, namely, temporary and permanent. The temporary carrier is one who carries the disease as long as 6 to 12 weeks, while the permanent carrier is one who carries the disease longer than 12 weeks. These people are dangerous because they may spread diseases to other people but may never be detected as the source. Carriers are also difficult problems because of the many unsolved factors related to the handling of them. It is the duty of the health department to find as many carriers as possible and to do the best that is known in handling them. For instance a carrier of typhoid germs may be working in a dairy. The individual is not sick but in handling the milk he may eventually contaminate it. The result is an epidemic of typhoid fever. The health department may trace the disease to this individual. Upon much treatment this individual may persist in carrying the germs. Such an individual can at least be under the supervision of the health department. He can be forbidden to do such type of work as may be instrumental in spreading diseases. Such supervision is indeed of utmost importance.

GENERAL MEASURES TO PREVENT THE SPREAD OF COMMUNICABLE DISEASE

Aside from specific measures taken to prevent spread of communicable disease, certain general measures must necessarily be instituted. These measures deal with controlling the agents which carry the disease. The three most important non-living agents which carry disease are water, food and human excreta. Therefore, water must be supervised against pollution, food supplies and especially milk must be under scrupulous supervision with special attention to the encouragement of pasteurization of milk, and the disposal of excreta must be placed under sanitary regulations.
The most important living agents that spread disease, excluding the human carriers, are mosquitoes, flies, rats, fleas, lice, and ticks. Special efforts must be made to control the growth and development of these vectors if such diseases as malaria, plague, typhus fever, yellow fever, spotted fever, and the like are to be prevented from becoming epidemic.

INCREASE THE RESISTANCE OF INDIVIDUALS IN THE COMMUNITY AGAINST SPECIFIC DISEASES.

There are some communicable diseases which are controlled by inoculation with vaccines and toxoids. A vaccine is a suspension of dead or living germs which when inoculated into or beneath the skin will produce immunity to a particular disease. A toxoid is neutralized toxin (poison) of a particular disease producing germs which when inoculated into or beneath the skin will produce immunity against that disease. There is a two-fold process in the body which fights diseases. This process is called resistance and its two-fold character is made up of its specific and non-specific fighting forces. The interpenetrating relation between those two forces is one of the most intriguing chapters in medical science. Specific resistance means bodily resistance against the development of a specific disease such as smallpox or typhoid or any other particular disease. Non-specific resistance means bodily resistance against the development of any number of diseases or any diseases. Specific resistance is developed in the body by its struggle against a specific disease germ. It could not develop without being in some way stimulated by the particular germ or the nocuous substances from that particular germ. In other words, specific resistance is the result of the body mobilizing and developing its fighting forces against the onslaught of a particular enemy or disease. It is interesting to note that during the process of mobilization and development of its army against a specific enemy, it also, in many instances, builds up a rather strong defense against any common enemy (any disease). This latter defense is non-specific resistance. Thus it can be seen that in the course of the development of specified resistance, there is also a certain amount of non-specific resistance which develops. But non-specific resistance has another important progenitor which is related to nutrition and environment. These latter factors build general non-specific resistance by supplying the raw material, the energy and the workmanship for the construction of the lines of defense. It is interesting to note also that in the development of non-specific resistance there is also a development of specific resistance. So one can readily see how intimately the forces of specific and non-specific resistance are intertwined - they closely interpenetrate each other. The stimulation of the one calls forth the stimulation of the other.

Specific resistance, as induced by vaccines and toxoids, i.e. artificial immunization is a method of disease control that has indeed been a miracle in medicine. The earliest disease to be fought by this method was smallpox (1774). Later came rabies (1885); then typhoid fever (1909); diphtheria (1912); scarlet fever (1924); rocky mountain spotted fever (1925); whooping cough (1933) and tetanus (1933). A tremendous field of vaccine and toxoid experimentation is going on all over the world for other diseases than those mentioned.

Artificial immunization together with sanitation have in the past served as the two greatest bulwarks that the public health organizations have used in their fight against the destructive epidemic diseases. When vaccination first began to be practiced, most of the world looked with suspicion and objection upon this procedure. Even the recognized intellects fought vigorously against this practice. Today the opposition is by no means insignificant although not great enough to force practices back to the level of the days of violent epidemic scourges. In the United States today there are ten states with compulsory smallpox vaccination laws, including a population of 32,500,000 and four states where smallpox vaccination is absolutely forbidden, including a population of 4,000,000. It is very significant to note that over a ten year period the ten states with 32,500,000 had less than half the number of smallpox cases than the four states with 4,000,000 population. From these figures one must be convinced of the effectiveness of smallpox vaccination. Lately, however, there has been a small but persistent increase in smallpox in this country. This is evidently due to relaxation in giving smallpox vaccination in the thirty-eight states that have no compulsory vaccination laws. Vaccination against smallpox should be compulsory in every community since it is the only effective method to control this dreaded disease.

There are periods of apathy among the population toward the precaution of vaccination.

These periods always occur in times when certain preventable diseases are absent from the community. Then when a few cases break out, there begins an uproarous clamor for vaccination, but such a procedure is usually too late, and all the damage that is going to be done proceeds without abatement. Such circumstances usually occur in relation to smallpox, typhoid fever and diphtheria. Vaccination during a typhoid epidemic is usually of small value so far as controlling the immediate ravages of the epidemic is concerned. This is due to the fact that it takes 5 to 6 weeks for the typhoid vaccination to become effective, whereas the incubation period of typhoid fever is 7 to 14 days. Thus during the prolonged period during which the immunity is being built up the epidemic has time to run wild. The time to vaccinate against typhoid fever is before an epidemic breaks out.

In diphtheria one meets the same problem. This disease has an even shorter incubation period (2 to 5 days) whereas the period of effectiveness of the toxoid begins 6 weeks to 3 months after the injection is given. Thus in 45 to 90 days untold ravages of life may occur. The time to administer diphtheria toxoid is between the 8th and 9th month after birth and at the time of entering school.

Immunization against scarlet fever, whooping cough and tetanus (lock jaw) is gradually progressing out of the purely experimental stage into the stage of recognized usefulness and effectiveness. Although some doubt still persists as to the effectiveness of the former two types of immunization, the latter (tetanus toxoid) is of undisputed value. The time will soon come when tetanus toxoid will be given together with diphtheria toxoid. There are also indications that vaccinations against scarlet fever and whooping cough should be used more widely. Undoubtedly the technique of preparing the vaccines for these two diseases will be improved in the future to place them in undisputed positions as part of the armamentaria of preventive medicine.

In order to make more plain how effective the preventive measures have been for the control of such diseases as diphtheria and typhoid fever, the following statistics are presented:

Decrease of typhoid fever in the U.S. Army following the introduction of vaccination

	Cases per 100,000 Population		Cases per 100,000 Population
1901 No vaccination	674	1909 Voluntary vaccination	335
1903 No vaccination	514	1911 Partial compulsory vaccination	85
1905 No vaccination	314	1913 Compulsory vaccination	4
1907 No vaccination	379		

Typhoid Death Rate for 28 Cities in U.S.

	Deaths per 100,000 Population		Deaths per 100,000 Population
1910	20.54	1925	3.44
1915	9.47	1930	1.61
1920	3.85	1933	1.18

Mortality Statistics from Diphtheria in 93 Large Cities in the U. S.

1923	13.13	1930	5.12
1925	9.67	1931	3.74
1927	10.36	1932	3.21
1929	7.82	1934	2.23

ACTIVE AND PASSIVE IMMUNITY

The difference between active and passive immunity must be understood. Active immunity is that type of protection against disease which the body itself builds up. This is illustrated by the protection which the body develops after being vaccinated for smallpox or typhoid fever. What happens in such a case is that certain substances are inoculated into the body. These substances stimulate the body to build up an army of defense against particular diseases. The army of defense consists of ultra-microscopic units which have the power to fight against diseases. These are called anti-bodies. Because the body itself takes an active part in building up these defense units, the condition is called "active immunity", and the procedure is called "active immunization".

Passive immunity is that type of protection against disease which the body receives from the outside and plays no part in building up. This is illustrated by the protection which is injected into the body in the form of serums or antitoxins for such diseases as diphtheria, tetanus, scarlet fever. A serum is the fluid or non-particulate part of the blood which contains antibodies against a particular disease. There are recognized at least 5 kinds of antibodies, namely, antitoxin, agglutinin, precipitin, lysin, and opsonin. An antitoxin is the fluid part of the blood which contains antitoxin antibodies against a particular disease. These substances do not stimulate the body to build a line of defense, they are themselves

the line of defense, i.e. antibodies. In other words, the body does not develop and organize its own army (antibodies) but the army is imported from the outside, just as any army of intervention is sent into a country from the outside. Because the body itself takes no active part in building up this defense mechanism, the condition is called "passive immunity" and the procedure is called "passive immunization".

These two types of immunization each serve a particular function. Active immunization serves to protect the body against the invasion of diseases. Passive immunization serves as an emergency brigade to fight off a defense that has already attacked the body. Thus diphtheria toxoid is injected into a well body for the purpose of building up an active defense mechanism against this disease in case that it might attack the body. It is a preventive protection against this disease and, of course, the most desired. Diphtheria antitoxin is injected into a body already sick with diphtheria because the body's defense mechanism against this disease had never been stimulated to build up an active defense; the antitoxin serves as an imported front line of defense; it is not a preventive protection but a therapeutic or curative protection. Active immunity lasts over an extended period of time. Passive immunity is short lived.

COMMUNICABLE DISEASE REGULATIONS AS PROVIDED BY THE LOUISIANA SANITARY CODE

Reportable Diseases: Amebiasis, anthrax, botulism, cancer, chancroid, chickenpox, cholera, dengue, diphtheria, dysentery-bacillary, encephalitis (infectious), erysipelas, food poisoning, glanders, gonorrhea, granuloma inguinale, hookworm, influenza, leprosy, lymphogranuloma venereum, malaria, measles, meningoccus meningitis, mumps, ophthalmia neonatorum, paratyphoid fever, pellagra, plague, pneumonia(acute lobar), poliomyelitis, puerperal septicemia, rabies, rabies in animals, scarlet fever, septic sore throat, smallpox, syphilis, tetanus, trachoma, tuberculosis (pulmonary), tuberculosis (other forms), tularemia, typhoid fever, typhus fever, undulant fever, whooping cough, yellow fever.

Every physician holding license to practice medicine in Louisiana has the duty of reporting to local health department and state health department every reportable disease which he attends.
Every parent, guardian, householder, attendant, or others in charge of a known or suspected communicable disease must report to local health department the disease within 24 hours of it becoming known.
No person shall interfere with or obstruct the entrance or examination of any building by any duly appointed health officer, or his accredited representative, or any duly authorized representative of the state department of health, when there has been reported to exist in said house a case of communicable disease.
No person shall interfere with, obstruct or mutilate or tear down any notices or placards, placed on house or premises by an authorized health authority or officer.
If any doubt arises as to diagnosis of a case of communicable disease, the state health officer may appoint one or more experts to examine or investigate the case. The decision of the state health officer as to diagnosis is final.
Whenever any person or animal dies of a suspected communicable disease, the state health officer or his duly authorized representative may order a postmortum examination performed on the body.
The teacher or principal of a school must refuse admission of a child to school when former has been notified by health authorities that a communicable disease exists in the child's household and must not admit child to school without a permit from local health officer.
Schools may be closed by health officer if in his opinion proper measures are not being taken against spread of a communicable disease, or for any reason he deems it necessary to protect the public health.
No person, except by permission of the local health officer, may carry or remove from one building to another any patient affected with any communicable disease.
No person affected with any communicable disease shall change his place of residence while suffering from such disease, except by permission of the local health officer.
There shall be no public or church funeral of any person who has died of a communicable disease, except by permission of local health officer and in compliance with strict regulations.
Persons who have been placed in isolation by the health officer, on account of contact with the deceased before death, or for other reason, shall not be permitted to attend the funeral except under such conditions of isolation from others as shall prevent the spread of infection from them.
Local health officer has the power to declare a person or building isolated to protect public health against communicable disease spread.

Isolation: Means the exclusion of the individual from school or other public places, or confinement to his or her living quarters, or both, for a prescribed period.

Quarantine: Means rigid isolation, in which all ingress and egress to and from the living

quarters of the affected individual is prohibited except by persons possessing a positive immunity against the disease.

Reference: (1) Public Health Administration in U.S. - Smillie

(2) Control of Communicable Disease - P. H. Reports

(3) Louisiana Sanitary Code

Basic Principles of Healthful Housing *

Second Edition

COMMITTEE ON THE HYGIENE OF HOUSING

AMERICAN PUBLIC HEALTH ASSOCIATION

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MAY, 1939

[redacted]

* This Report has not been approved as a standard publication by the American Public Health Association's Committee on Research and Standards but has been endorsed by that Committee for release so that it may be made available for study.

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TOGETHER with food and clothing, shelter is a fundamental need of human existence. No housing program can be sound unless the shelter it provides is healthful. It was recognition of this fact which led the American Public Health Association to organize a Committee on the Hygiene of Housing as an agency to study and promulgate the principles of healthful housing, to link the interests and skills of technicians in public health and housing, and to serve as the organ of coöperation for the United States with the Housing Commission of the Health Organisation of the League of Nations.

In beginning the work of this committee, it seemed essential to formulate the basic health needs which housing should subserve. This report is such a formulation. It consists of thirty basic Principles, with Specific Requirements and suggested Methods of Attainment for each. The Principles and Specific Requirements are believed to be fundamental minima required for the promotion of physical, mental, and social health, essential in low-rent as well as high-cost housing, on the farm as well as in the city dwelling. Under Methods of Attainment are suggested the more important means by which these requirements can be met, without considering in all cases alternative means of attaining the same ends.

In view of the present status of the housing program in the United States, particular emphasis has been placed, in drafting these Methods of Attainment, on the needs of new urban construction. The Principles and Specific Requirements, however, should prove equally valid as a guide for new rural construction or for the appraisal of older housing, whether rural or urban, since they are based on fundamental biological requirements of the human organism.

Many of the objectives treated here involve problems of housing management, as well as of planning and construction. This must be the case if we are to achieve human decency and satisfaction, and are not merely concerned with requirements on paper. Under a policy of continuing management responsibility on the part of housing development agencies, generally accepted as the soundest basis for a large-scale housing program, it should be possible to approve given types of housing facilities only for stated conditions of occupancy, just as elevators have long been licensed to carry only a certain number of passengers, or warehouses a given floor load.

This report necessarily devotes much space to consideration of needed mechanical installations in the home. The committee, therefore, particularly wishes to emphasize that the best of mechanical equipment will not compensate for mediocre planning, and that in some instances the need for mechanical equipment will in fact be lessened by proper design of the dwelling and skillful adaptation of buildings to their natural environment. In other words, as demonstrated in the report, mechanical devices for summer cooling in the ordinary dwelling are often a troublesome, and at best a costly, substitute for good site-planning which promotes ventilation of the home by natural air currents. Nor is electric light in the kitchen an acceptable sub-

stitute for sunshine during the daylight hours.

The present revised edition (of our first report which was prepared in 1938) incorporates numerous findings based on researches of the committee members and staff during the past year. Among the Principles which have thus been clarified or strengthened, particular mention may be made of the first eight, comprising Section A, as well as Principles 10, 12, and 25. It is hoped that continuing researches of the committee may lead to still further revision and amplification of this report in the light of accumulating knowledge.

Grateful acknowledgment is made to the Milbank Memorial Fund for its understanding of the committee's purposes, and for financial support, without which the committee could not have functioned nor this report materialized.

SECTION A

Fundamental Physiological Needs

Principle 1. Maintenance of a thermal environment which will avoid undue heat loss from the human body

a. *Specific Requirements*—The four factors controlling heat loss from the human body are air temperature, mean radiant temperature of surrounding surfaces (walls, windows, radiators, human bodies, open fires), relative humidity, and air movement. In an ordinary dwelling, under winter conditions, air temperature and mean radiant temperature are the chief variables, since neither air movement nor humidity is likely to be considerable. The combined effect of air temperature and mean radiant (or wall) temperature is defined as "operative temperature." For ordinary dwelling conditions, operative temperature may be taken as approximately the mean between air temperature and wall temperature. For the normally vigorous person, normally clothed, and at rest, an operative temperature of 65° F. is the minimum. In all regularly occupied rooms this temperature should be provided at knee-height, 18 in., in order to prevent chilling of the legs and feet. Air temperature may be increased or decreased in order to compensate for deviations of mean radiant temperature above or below air temperature.

In rooms occupied by persons of subnormal vitality, operative temperatures must be higher than 65° F. Since dwellings should be designed for occupancy both by old people and by young children who may play on the floor, the heating system should be able to provide an operative temperature of 70° F. at knee-height under ordinary winter conditions. Such a temperature may, however, be unduly high for the normal adult and need not necessarily be maintained.

Considerable vertical differentials of air temperatures are highly undesirable, since they involve waste of fuel (from increased heat loss through the upper areas of the room), and since they not only produce local chilling of the lower extremities, but also increase convection currents. With ideal heating, ankle-height temperatures and 5 ft. temperatures would be almost identical. Unfortunately, however, temperatures at ankle-height are often 65° F. with 70° at 5 ft. levels and 80° at ceiling height: a total differential of 15°. In very poorly heated houses, differentials of 30° and more have been observed.

No temperature conditions are ideal unless they can be held reasonably constant when desired, regardless of unpredictable changes in weather. It is equally important, however, that quick changes in temperature be possible to meet emergency requirements.

b. *Methods of Attainment*—The practical measures to be taken in housing design to meet these needs must, of course, depend upon climate, but it should be possible to reach the limiting temperature of 70° F. at knee-height under ordinary minimum winter conditions for the locality concerned. The usual figure for outside temperature taken by engineers as a basis for their computations is 15° F. above the lowest recorded temperature for a 10 year period.

The heating equipment provided will

also, of course, be closely related to the insulation of the building. Superior types of construction, weather-stripping and the use of double windows, and the use of insulating materials in ceilings and walls may, in cold climates, reduce heating costs by 50 per cent or more. Such insulating capacity should, therefore, be provided as is justified by fuel economy balanced against additional construction costs. The balancing of these factors is a problem deserving special study.

Insulation, as normally used for heating economy, has a particularly beneficial effect in reducing temperature gradients or differentials from floor to ceiling. Customary differentials ranging from 10° to 20° between floor and ceiling in an uninsulated house may be reduced below 10° when insulation is installed.

For low-rent housing in one- or two-story dwellings, the free-standing circulating heater type of stove will generally prove the most economical heating equipment, although frequently yielding poor conditions of thermal comfort. Current experiments in low-cost dwellings indicate that such a circulating heater, when enclosed in a central distribution chamber, discharging warm air to adjacent rooms through grilles, may produce thermal conditions superior to those associated with the free-standing circulator. For apartments, and perhaps for large groups of one- and two-family houses, steam heat from a central plant should prove as economical as stove heat. Central heating cannot wisely be replaced by stoves in the multi-story dwelling because of fire hazard and the problems of fuel storage and ash disposal.

For certain installations, hot water heating may have advantages. Indirect heating by hot air may also be employed. Where indirect heating involves considerable air change, permissible lower limits of temperature may have to be raised (to balance increased rates of convection loss from the body).

The ideal condition of almost identical temperatures at ankle-height and 5 ft. level can be obtained by radiant heating, with the use of large area units installed in the floor or placed low in the wall around two or three sides of the room. The possibilities of low temperature radiant heating by steam or hot water or, where power rates are low, by electricity, should be given careful consideration.

Thermostats are the most effective means of obtaining constant temperatures. At least one thermostat per dwelling unit should be considered where the cost may be justified by probable fuel economy. It is imperative, however, that manual control of thermostats and heat sources also be available in each dwelling unit. Different families usually prefer and often require different temperatures to meet special needs.

Flooring materials of high heat-conducting value should be avoided, particularly where children may play upon the floor. Loss of body heat by radiation to windows may be controlled by curtains. Excessive dampness combined with low temperature will increase heat loss from the body and may cause chilling, but this condition is not common in the United States.

It should be particularly emphasized that bedrooms need not always be maintained at 65° F. when unoccupied, or when occupied for sleeping.

If intermittent radiant heating is available the bathroom may also be maintained at a lower temperature. Additional local heating units, on the other hand, may be necessary in rooms occupied by persons of subnormal vitality.

Principle 2. Maintenance of a thermal environment which will permit

adequate heat loss from the human body

a. *Specific Requirements*—The factors involved here are, again, air temperature, mean radiant temperature of the surrounding surfaces, relative humidity, and air movement. In cold weather, air movement and relative humidity inside the dwelling will normally be low, and the determining factor will be operative temperature, which should not exceed 75° F. within the zone of occupancy. In warm weather, humidity will decrease the limit of tolerance, and air movement will increase it. The human body is of course acclimated to higher temperatures in summer than in winter.

It is particularly important that cool moving air be made available in sleeping-rooms, since the impact of cool air is of great value in promoting healthful sleep.

b. *Methods of Attainment*—Overheating in the winter season is all too prevalent in modern housing. It should be possible to eliminate this condition through adequate controls of local heat sources with a minimum use of windows. In the case of steam-heated dwellings, both effective operation of central heating plants and a maximum of individual control of heat supply to each room are essential for satisfactory results. In large buildings and in housing projects, zone control of the steam supply produces greater efficiency.

In summer, air cooling and air dehumidification are valuable adjuncts to comfort, but are beyond the present economic limits of the low-rent dwelling. In the free-standing house, the installation of an exhaust fan at the top of the house to draw in cool night air through windows is also an extremely helpful procedure. It would seem not unreasonable to include in the equipment of the home at least one electric fan for cooling, in regions where summer heat is considerable.

Even in the low-rent home, we must insist on adequate through- or cross-ventilation. Windows should be so placed as to assure adequate circulation throughout each room, and their open area should extend close to the ceiling, within 6 in. if possible, to permit hot air in the upper part of the room to escape. Windows of the casement type which swing either horizontally or vertically may be superior to the double-hung type if their entire area is made effective for ventilation. An additional advantage of the swinging type of sash is the possibility of controlling the direction of circulation by setting the angle of its panels. Heat loss by infiltration around window casements during the winter should also be considered in the selection of type of window. All double-hung windows should open at top and bottom. Adequate window area and careful placement of windows are especially important in kitchens, to remove heat resulting from cooking.

Exposure to prevailing summer winds is a major factor in securing comfort through high air movement during hot weather. Both warming in winter and cooling in summer are materially aided by suitable orientation of the dwelling toward the sun, as discussed under Principle 5. Summer sunshine, especially in the late afternoon, may be extremely undesirable, particularly in small apartments where all of the rooms face in one direction. This factor renders an unobstructed west or northwest exposure unfortunate since there is practically no means of excluding sun heat falling on walls facing in this direction during the late afternoon in the early summer.

Principle 3. Provision of an atmosphere of reasonable chemical purity

a. *Specific Requirements*—The important atmospheric impurities present in the home under ordinary conditions

are those contributed by cooking, by various heat sources, and those derived from the human body. When windows are open, fumes, odors, and soot from neighborhood sources may be present. (Hazards from heating sources and those associated with special toxic gases are considered under Principle 28.)

The odors given off from the body have been proved to exert a definitely harmful influence upon appetite and therefore upon health. With persons of reasonable cleanliness the dilution of these odors will require an air change of 10 cu. ft. per person per minute.

b. *Methods of Attainment*—Such an air change as this, with any ordinary type of construction, will be automatically attained in cold weather by normal leakage through walls and ceilings of ordinary porosity and around normally constructed doors and windows, provided the cubic space per occupant is 400 cu. ft. in any occupied room, and that the normal ratio of fenestration is supplied. The necessary air change can be secured in summer by the opening of windows. Since this minimum of 400 cu. ft. is demanded by other fundamental needs to be discussed in later sections, no other provision for air change need ordinarily be made in the low-rent dwelling. If the other fundamental needs could be met, and if dependable artificial ventilation were provided, a lesser air space might be permissible.

It should be noted that this standard of 400 cu. ft. applies to any occupied room. Where separate rooms are used for living and sleeping, the total for the habitable portions of the dwelling must be 800 cu. ft. per person. Where this total volume for the dwelling as a whole is provided, it may be unobjectionable to permit space in sleeping-rooms to fall somewhat below the 400 cu. ft. standard, provided that functional arrangement of furniture is not interfered with. Where the same room is used for both living and sleeping, the value should be increased from 400 cu. ft. to at least 500 cu. ft. to allow for necessary furniture.

Ceiling height may, in general, be determined by cubic space requirements and by necessary window heights.

Noxious fumes and odors, and unpleasant soot and grime from industrial and other neighborhood sources are not always subject to effective control under regulations governing nuisances. Their presence in the neighborhood and the direction of prevailing winds which carry them are factors which should be considered in the choice of housing sites.

Principle 4. Provision of adequate daylight illumination and avoidance of undue daylight glare

a. *Specific Requirements*—In order to avoid danger of eye strain and facilitate cleanliness, the minimum light value available for any occupied space relying upon natural illumination should be 6 foot candles, measured on a horizontal plane 30 in. above the floor. Windows should be so placed in the rooms of a dwelling as to afford the greatest illumination possible, without glare or shadows, for the optical tasks that are expected to be performed at certain locations in these rooms.

b. *Methods of Attainment*—With unobstructed exposure to the sky, the minimum illumination defined above will be obtained in clear weather and up to a reasonable time before sunset (in the latitude of Washington, D. C., 39°) with an area of window glass equal to 15 per cent of the floor space of a room (provided that walls and ceiling are light in color).

For locations in the United States other than Washington, D. C., the minimum window area can be either increased or decreased in proportion to the average brightness of the sky in

that locality. This brightness will depend in any locality upon the latitude, altitude, amount of air pollution, and relative humidity of the region. Figures for the daylight illumination and brightness of the sky for different regions and latitudes of the United States which have been given by the Weather Bureau and the U. S. Public Health Service show that for the same latitude the average daylight illumination is about 25 per cent higher for the Plains states (those lying between the Mississippi River and the Rocky Mountains) and about 46 per cent higher for the Plateau states (those lying between the Rocky Mountains and the Sierra Nevada and Cascade Mountains) than for the Eastern states. It is possible, therefore, that for the same latitude in Plains and Plateau states the necessary window area may be less than in the Eastern states.

To correct for latitude, the area of the window might perhaps be increased by about 2 per cent of its own value at 39° for every degree north of that latitude, and decreased by about 2 per cent of its own value at 39° for every degree south of that latitude. Thus, at 45° latitude, the required window area would be increased by about one-eighth, or to approximately 17 per cent of the floor area. These recommendations assume a generally clear atmosphere and normal horizons.

Buildings must be spaced sufficiently far apart so as not materially to obstruct sky shine. It seems reasonable to require that the sky angle at the lowest window sill be not less than 45°, which implies that the width of intervening street or court space should approximate at least the height of opposite buildings. The loss of light due to the obstruction of the sky by opposite buildings may, however, within limits, be approximately compensated for by an increase in the ratio of the glass area of the window to the floor area by 1 per cent for every 4° decrease in the sky angle. Thus, the glass-area floor-area ratio for sky angles from 90° to 86° would be equal to 15 per cent; from 86° to 82° to 16 per cent; from 82° to 78° to 17 per cent; etc. Since it is desirable, from the viewpoint both of ventilation and of lighting as discussed below, that the tops of windows be as near to the ceiling as is structurally possible, the proposed increase in the area of the windows should be obtained by increasing their width.

All rooms, including bathrooms, should have at least one window opening to the outer air (except in the case of specially lighted and ventilated bathrooms in hotels and such large multifamily dwellings as have ample economic resources for maintenance and domestic servicing). Daylight illumination should be provided for public halls and stairs, except perhaps in elevator apartments with adequate janitor service.

It is of advantage to have the tops of windows as near to the ceiling as possible, to give the greatest sky angle in all parts of the room and thus to secure the greatest lighting effectiveness. Kitchen windows especially should be so located as to supply light without shadows for the performance of culinary tasks. Inside walls of a good reflecting value (reflection factor at least 50 per cent) are essential factors in obtaining the desired result. Glossy paint should be avoided on account of glare: ceilings should be matt white or of a lighter color than the walls (reflection factor at least 70 per cent). The finish of wall and ceiling surfaces should be such as to facilitate cleaning, in order to retain original reflecting values.

For control of glare, suitable window shades are essential; those of the Venetian blind type, although costly and difficult to keep clean, are desir-

able, since they protect from glare while reflecting light to the inner part of the room. Windows extending below 30 in. from the floor tend to cause glare and obstruct furniture placement without materially increasing general illumination.

Rooms having windows which face covered porches should be supplied with more than the normal ratio of glass area. The darkening effect of porches can be reduced by the finishing of porch ceilings with colors having high reflecting values.

It should be noted that good natural lighting is often interfered with by internal obstructions, such as draperies and furniture. It would be of advantage, where available light is near the desirable limit, so to place curtain rods that draperies may be hung adjacent to, rather than over, the windows.

Principle 5. Provision for admission of direct sunlight

a. *Specific Requirements*—No definite quantitative limits can be set; but it is clearly desirable for all dwellings, and essential for those occupied by persons who are housebound, that direct sunlight should enter at some places and hours, especially in winter. Sunlight, particularly through its ultraviolet components, provides valuable physiological stimulation.

b. *Methods of Attainment* — Insolation in a given room depends on sky angle as related to that area of the sky occupied by the sun's orbit at a given season. It will be materially influenced by the orientation of buildings and by their spacing as discussed under Principle 4, by adjacent buildings or projections so located as to cut off the early morning and late afternoon sun, and by the placement of windows in the various rooms.

In the northern latitudes of the United States, a generally southerly orientation of rooms for daytime occupancy is most desirable since it gives a maximum of sunlight in winter. In order that sunshine may penetrate to the yard on both sides of a row structure, however, it is desirable that such structures be oriented to face about 20° or at the most 30° either east or west of south. In this connection it should be noted that streets running directly east and west suffer a great disadvantage, since their surfaces receive a minimum amount of sunlight —perhaps none at all—during the winter months, because of the shadows of buildings on their southern frontage. Ice and snow may remain frozen on such streets for long periods. Streets which run northeast-southwest or northwest-southeast, however, will receive some sunlight during every clear day of the year.

Within buildings which are properly oriented to the sun, the locations of individual rooms should be studied to provide desirable insolation during the hours of their use. If the living-room and kitchen—the rooms most occupied during the daytime—face the southeast rather than the southwest, they will receive their summer sun at a relatively cool time of day.

Utilization of the sun's heat in winter to lessen the costs of heating is an important possibility which has been little explored. Experimental work by Henry N. Wright has indicated that rooms or dwellings which supplement a southerly exposure with large window areas may require virtually no artificial heat on clear winter days, even in northern climates. The effectiveness of such natural heating depends on adaptation to local meteorological conditions. The relation of orientation to local meteorological conditions should be studied for various areas.

In determining the orientation of buildings, it should of course be borne in mind that exposure to prevailing

summer winds is essential to comfort, and that compromises between ideal orientation toward sun and wind, respectively, may be necessary.

In rooms which have east or west exposures, placement of windows as far to the south as practicable will favor maximum penetration of sunshine.

Casement windows which open substantially throughout their area are more desirable than double-hung windows from the standpoint of admitting the ultra-violet rays of sunlight.

Principle 6. Provision of adequate artificial illumination and avoidance of glare

a. *Specific Requirements* — Artificial illumination of 6 foot candles should be generally available over 25 per cent of the floor area in each occupied room, with at least 15 foot candles of local illumination at certain points for reading, study, or sewing. Illumination of at least 1 foot candle should be provided on stairs and in passageways to minimize danger of accidents. Glare effects should be avoided in the design and location of fixtures.

b. *Methods of Attainment* — The maintenance of the illumination specified above, and the avoidance of accident hazards due to oil lamps, can be attained only by the use of electricity. Electric lighting should be considered a minimum requirement for the healthful American home.

There should be a central outlet in the ceiling of each room, with at least two convenience outlets in the living-room and at least one in each of the other rooms. In the kitchen, shadows on the sink and work table should be avoided, if necessary by installing a second fixture. In the bathroom the central fixture may be replaced by lighting adjacent to the mirror.

For the control of glare, all bulbs should be shielded from view by suitable globes or translucent reflectors or shades, so that the brightness contrast between the light source and its adjacent background does not cause visual discomfort. Ceiling fixtures providing semi-indirect lighting are highly satisfactory sources of general illumination, and floor lamps of the direct-indirect type supply an excellent balance of local and general illumination. The shades of table and floor lamps should be of sufficient thickness and of such color that their surfaces will not be a source of glare when the lamps are lighted. Translucent globes providing direct lighting often produce uncomfortable brightness contrasts, but when located close to the ceiling, out of the normal field of view, may be satisfactory in kitchens and bathrooms. All fixtures and bulbs should be cleaned periodically to retain lighting efficiency.

Sleeping-rooms should be protected from external artificial light sources such as street lamps and electric signs.

Principle 7. Protection against excessive noise

a. *Specific Requirements*—Excessive noise, a factor much neglected in the United States, is of serious moment in so far as it causes nerve strain and interferes with sleep and other physiological processes. It should be possible to exclude noises from outside the dwelling unit to such a degree that within that unit the noise level shall not exceed 50 decibels; and a level as low as 30 decibels should be attainable in rooms used for study or sleeping. These standards are based on European practice and call for further examination under conditions in America, where the prevalence of radios and automobiles raises new and serious problems.

b. *Methods of Attainment*—The solution of this problem depends, first of all, on the control of external sources of noise, which involves the avoidance of dwelling sites with exposure to

special sources of noise (factories, highways, railroads, athletic fields, and the like), and the control of motor horns and radios. Small enclosed courts should be avoided in housing developments, since noise may be reflected from the building walls.

For control of noises transmitted by air within a multi-family dwelling, party walls should effect a reduction of about 50 decibels (approximately the result produced by an 8 in. brick wall). Apartment doors opening onto public passageways should be fitted so as to exclude noise.

For the control of structure-borne noises, floors and ceilings should be constructed to effect a reduction of 15 decibels of impact noise. Such a floor will be adequately insulated against air-borne noise. Construction consisting of two thicknesses of wood flooring on standard joists, with lath and plaster ceiling, usually effects a reduction of 10 to 15 decibels. If the laths or ceiling boards are fastened to the joists with spring clips and the floor is laid so as to permit a small amount of "play" between the sub-floor and the joists, a reduction well above 15 decibels may be obtained. Concrete floors, although adequate for the reduction of air-borne noise, normally effect no reduction in impact noises such as footsteps, scraping of chairs, etc. All plumbing, steam pipes, and valves should be correctly designed, so that steam "hammer" and "singing" valves cannot occur. Refrigeration and heating equipment, pumps, and blowers should be so installed that their vibration cannot be transmitted through the dwelling structure. Plumbing stacks should preferably not be located in living-room or bedroom walls.

Principle 8. Provision of adequate space for exercise and for the play of children

a. *Specific Requirements* — Opportunities for physical exercise and recreation, for both children and adults, are essential to a sense of organic well-being and the enjoyment of mental health. While these ends may be considered as primarily psychological in nature, they are attained by physiological processes and may therefore be considered under the present category.

The attainment of the purposes indicated requires consideration of the reciprocal relations between internal space for social use and external provision for recreation. There should be adequate floor area within the dwelling, and outside space suitable for organized recreation, meeting the needs for different groups and sexes and located so as to serve their convenience with the greatest possible economy in construction and maintenance.

Standards for outdoor recreation areas in new housing developments have been the object of careful study by a committee appointed in October, 1938, by the National Recreation Congress. This committee has since published a report, entitled "Play Space in New Neighborhoods," which provides a sound basis for estimating local neighborhood needs where the characteristics of the population and of the area to be served are known. While it is probable that the standard commonly cited (10 acres per 1,000 persons for all types of recreational areas, including metropolitan regional parks and reservations) may not be excessive when applied on a city-wide basis, it is obvious that local needs for recreation space can be met only after a detailed study has been made of specific neighborhood requirements. A study of the recommendations of the committee appointed by the National Recreation Congress indicates that the area needed for local playgrounds and playfields (including playlots for children of preschool age) varies from about 2½ acres per 1,000 persons, in

the case of a neighborhood housing 1,800 families, to 3 acres per 1,000 persons for a neighborhood of one-third this population (assuming in each case the same age group composition and family size). In a neighborhood of 1,800 families with a population density of 10 families per gross acre, such a standard would require the setting aside of 10 per cent of the area for this purpose, whereas a density three times as great would increase the proportion of open space required for active recreation to 30 per cent of the gross area.

b. *Methods of Attainment*—For city dwellers it has been suggested that the recreation area should include a playground within such distance as to be practically accessible, and an athletic field within half a mile of each home for the use of adolescents. It is desirable to provide play spaces for very young children (separate from those of adolescents) within each block or large group of dwellings, so as to facilitate parental supervision and minimize traffic hazards.

Planning for recreation is obviously a problem in city or neighborhood planning, and the optimum size and effective radius of indoor and outdoor recreational facilities will greatly influence the determination of neighborhood boundaries. Not only must the physical characteristics of the neighborhood be recognized, but also the varying needs of the people to be served. This implies knowledge of the characteristics of the population (preferably classified by age, race, occupation, and economic and social status) and the relation of these characteristics to individual and group recreation habits.

The subject of standards for recreation space is receiving further study by this committee.

It should be emphasized that provision of recreation facilities is by no means necessarily a function of housing authorities. Such facilities are logically chargeable to the community as a whole, rather than to a specific housing project. Yet it is clearly the responsibility of the housing authorities to be certain that such facilities are, or will be, available before approving a housing scheme. In large urban developments the management may make provision for trained leaders of club and recreational activities if such service is not otherwise available.

SECTION B

FUNDAMENTAL PSYCHOLOGICAL NEEDS

Principle 9. Provision of adequate privacy for the individual

a. *Specific Requirements* — The essential concept of a home involves the possibility of that isolation from the world which every human being sometimes craves and needs. Especially in cities, the home is a needed refuge from the noise and tension of the street and market place. The same principle applies within the home itself. When the dwelling unit is crowded, frequent personal contacts may be the cause of nervous irritation, as detrimental to mental health as is the more obvious influence of contact infection upon physical health. " A room of one's own " is the ideal in this respect; but we can at least insist on a room shared with not more than one other person as an essential minimum. Such a room should be occupied only by persons of the same sex except for married couples and young children. The age at which separation of sexes should occur is fixed by law in England at 10 years,

but some American authorities would place the figure 2 years lower. Sleeping-rooms of children above the age of 2 years, according to psychiatric opinion, should be separate from those of parents.

Furthermore, fundamental habits of decency demand that toilets, bathrooms, and bedrooms should be accessible from halls or living-rooms without passing through other bedrooms or bathrooms.

Dwellings should be so spaced on their sites, and their windows so located, as to limit direct vision from one dwelling into the bedrooms and bathrooms of another.

b. *Methods of Attainment*—The objectives stated can be attained by various types of design, but they imply in practice at least the standards enforced under the current English legislation on overcrowding. Under this legislation, not more than 2 persons may occupy a sleeping-room. Two rooms are required for 3 persons, 3 rooms for 5 persons, 4 rooms for 7½ persons, and so on. Bathrooms and sculleries are not counted as rooms. For the purpose of governing occupancy, infants under 1 year of age are not counted, and children between 1 year and 10 years are counted as half-persons.

It is desirable to provide sleeping space apart from the living-room, but when this cannot be done, the living-room must be provided with reasonable privacy, as outlined above.

Overcrowding cannot be prevented either by proper physical planning alone or by good planning plus care in the initial selection of tenants. It is also necessary that continuing supervision be exercised and that adjustments to changing family needs be made by management authorities. Limitation of boarders, control of subleasing, intelligent adjustment of rent schedules to family size and income, sympathetic handling of transfers or other problems due to changing family size or income are all involved in maintaining desirable conditions of privacy.

Principle 10. Provision of opportunities for normal family life

a. *Specific Requirements*—Privacy is one element in normal family life; but sociability is another, which is psychologically and socially quite as important. Opportunity for adolescent youth to meet persons of the opposite sex under wholesome conditions should be provided. To meet these needs a common living-room which can be occupied by all members of the family, plus reasonable space elsewhere for withdrawal during periods of entertainment, would seem essential. In situations where space within the dwelling unit must be restricted to the minimum required for everyday routines of the family, it is desirable to supply supplementary facilities, outside of the dwelling unit, which will accommodate the occasional or extraordinary needs of the family (such as entertaining and ceremonial observances) which would tax the capacity of the home and might lead to friction within the family or with neighbors. The characteristic needs of large, small, and specially-composed households must be met. It is important for the establishment of friendships and the striking of family roots in the chosen community that continuous residence in that community should be possible through all the normal changes in family size and make-up; such continuity should be fostered by the provision in every housing development of living units adapted to families of various sizes and types.

b. *Methods of Attainment*—Living-space in the dwelling unit must be so organized as to provide a suitable gathering-place for members of the household and their guests. Whether this

space be provided in the form of a separate living-room or, as may sometimes be desirable, in the form of combined kitchen and living-room, it is necessary that 400 cu. ft. of living-space be supplied per person, as specified in Principle 3.

To design the home merely in terms of the recognized room labels— "living-room," "first bedroom," "kitchen," etc.—offers no guarantee that the functional needs of the family will be met. The functions themselves must be clearly visualized and provided for in terms of the social group which it is proposed to house. Provision must be made for group activities of the family, such as reception of visitors, recreation and reading; for withdrawal of individuals for study or rest during periods of family activity; for sleeping, with its related functions of clothing storage; for food preparation, the serving of meals, dishwashing, laundering, and housecleaning, with their related needs for the storage of supplies and equipment and the disposal of wastes; for children's play, and for adult or adolescent hobbies; for the overnight accommodation of relatives or other guests; for personal hygiene, with particular reference to the problems of baby care and laundering for infants; and for the storage of miscellaneous household goods such as playthings, luggage, card tables, and sports equipment.

Some of these needs can best be served outside the dwelling unit itself, by facilities which will meet the requirements of many families on a staggered schedule. Club- or assembly-rooms, which have been found vital in many housing developments, will provide for certain kinds of family entertainment and for occasional ceremonies such as weddings, anniversary or religious observances, and the like. They may also provide the needed opportunity for adolescent youth to meet persons of the opposite sex under wholesome conditions and without the expense of movie-going or other commercial recreation. The provision of communal laundry rooms, and of space which may be equipped by the residents themselves for nurseries or workshops, may make it possible to obtain coöperatively certain equipment or services which no individual family could afford.

In at least one recent housing project the problem of accommodating overnight guests has been met by reserving a special dwelling unit for their use. It should be possible in large-scale housing developments not only to experiment further with this principle of peak-load dormitory facilities but to extend it to cover the needs of persons quarantined during sickness.

Use overcrowding may result, even in the well planned dwelling, from inappropriate or badly placed furniture, especially when the new dwelling differs so markedly in plan from the old that customary patterns of living do not exploit the new opportunities. In such cases an important contribution to family life can be made by the housing management through simple suggestions as to desirable furniture arrangements or even, as has been done in certain projects, by giving help in the procurement of furniture appropriate to the new dwelling.

The continuance of the family in the community of its choice will be greatly fostered by the provision in every housing project of living units sufficiently varied in size to provide accommodations during the whole cycle of family development, from the phase of child rearing and gradually increasing family size, on to the period when parents whose grown children have set up their own homes will normally live by themselves. Related problems which must be solved by the planner are those of the non-typical household,

such as the group of employed adults unrelated to one another and possibly desiring more than normal privacy, or the normal family plus grandparents or with an invalid member—in which cases unusual quiet or special access to the sun may be required. It is obvious that no advance provision can be made for each of these contingencies exactly as it will occur; the plea, however, can be made that the designers of housing visualize as fully as they can the varied uses of family life to which their buildings will be put, and that they provide all reasonable variety in plan arrangements. The housing needs of a population are not met by devising standard 3 and 4 and 6 room unit plans and repeating them endlessly without variation simply because they are efficient users of space and have an economical relation to plumbing stacks and stairs.

In this connection it is worthy of note that a responsible group of housing managers have recently cited as their greatest difficulty that of reconciling the living units they have to offer with the living needs of the families who apply to them for space. The conclusion seems warranted that these fundamental needs of family life have been seriously neglected in much recent American housing.

Principle 11. Provision of opportunities for normal community life

a. *Specific Requirements* — In order to promote the psychological and social values which result from participation in normal community life, the home should be located in a community which contains or has easy access to the basic institutions of culture and commerce, and from which the major centers of employment can be reached without undue expense or loss of time and energy in travel.

Among the community facilities which should be made conveniently accessible to the home, the most important are: schools, churches, facilities for necessary local shopping and entertainment, libraries, and medical service. (Facilities for physical recreation have been discussed above.)

A vital community life should be fostered in housing developments by supplying, as a part of any new physical plant, the basic neighborhood facilities which are lacking, and by management policies which will encourage spontaneous community organization.

b. *Methods of Attainment* — This principle involves town and community planning and housing management as well as housing design in its narrower sense. It is, however, directly related to the choice of sites for housing projects and the plans for their subsequent development.

The school and the work place are vital elements in the community background of the home; they should be within reach without undue expenditure of time, energy, or money. Location of the school beyond a walking distance for the child may restrict his participation in normal and desirable extra-curricular activities. If adults are required to spend an excessive amount of time daily in going to and from work, they may be subjected to considerable nervous and physical strain, and the time and energy available for recreation or participation in neighborhood activities will be materially curtailed. Suitability of location is obviously related to transportation facilities and to the family carfare budget, so that no definite standards can be set; yet the point is often of controlling importance in the selection of sites for housing development.

The provision, as an integral part of new housing developments, of community workshops and of health centers or clinics which function under the existing local public health service appears to offer sound possibilities

which have been little explored.

Although the attitudes of local governments and housing management toward the autonomous community life of housing projects should be sympathetic, great care should be taken to avoid freezing the lines of social cleavage that may so easily form around the project dwellers as a privileged group in the community. Management authorities should be alert both to encourage natural neighborhood groupings and to take advantage of normal social services existing in the area.

It should be noted that many recent housing projects not only meet the basic needs cited above but provide important opportunities for economic coöperation and a sense of community responsibility far greater than is ordinarily attained in either urban or rural life. It seems possible that in this regard our housing program is making a substantial contribution to the most vital of all American political needs—the consciousness of and participation in the common tasks of community living.

Principle 12. Provision of facilities which make possible the performance of the tasks of the household without undue physical and mental fatigue

a. *Specific Requirements*—This principle involves avoidance both of physiological and psychological factors contributing to fatigue. The home is not merely a dwelling; for the housewife it is a work place as well. Recent studies show that some 60 person-hours of home-making activities per week are required in the average home. The principles of sound industrial hygiene demand directness of circulation and good facilities for storage, cooking, laundering, and refuse disposal. Cleansing, which is also important in this connection, is discussed under Principle 13.

b. *Methods of Attainment*—In order to minimize fatigue from needless walking in the performance of household tasks, halls and doors should be so located that internal circulation is direct and access to outside entrances (both front and rear) convenient, especially from the kitchen. Door swings should be so arranged as to minimize interference with other doors, with furniture placement, or with circulation. Easy access to the ground is important to the housewife when she has packages to carry in, the baby to be sunned, or washing to be hung out. Walk-up apartments should therefore be limited in height to 3 stories.

So far as storage is concerned, home economics authorities emphasize the need for a closet or wardrobe at least 22 in. deep and 3 ft. or more in width for each bedroom, cupboard space in the kitchen (protected against dust and flies), provision for storing brooms and ironing-boards, and additional general storage space for miscellaneous objects other than personal clothing and kitchen equipment. In multiple-dwellings a common storage space for baby carriages and bicycles should be provided, accessible by a ramp if not at grade.

From the standpoint of equipment, the kitchen should be provided with a suitable range. In urban areas a gas or electric range is desirable, which must meet the standards of safety discussed in a succeeding section.

The best height for any work surface depends upon the size and the proportions of the worker and upon the nature of the task. When the height of the work surface is not suited to the worker or to the job, the wrong muscles are used, and this, if continued, may result in sagging abdominal muscles and organs, spinal curvatures, round shoulders, and crowded lungs, through the stooped position into which the worker is forced when the work surface is too low or through the unnatural

lifting of the shoulders necessitated by a surface which is too high.

In a recent study of the heights preferred for different kitchen tasks by 562 American women, it was found that 82 per cent of them could use, without being conscious of strain, a dishwashing height of 32½ in., and 92 per cent a rolling height of 33½ in. The height preferred for beating was in most cases 2 in. less than that for rolling. While preferred heights are not always the best heights as measured by the output of work, studies of output of kitchen work have not been made, or at any rate have not been reported. For the present, then, it would seem that dwellings which are to be rented should have work surfaces of the heights indicated. This means a sink with the bottom set 32½ in. above the floor and a work surface to serve for beating and mixing set 31½ in. above the floor. The rolling surface may be a board built up at the edges to a thickness of 2 in., which when laid on the work surface will be the right height for rolling.

When the sink is set at the correct height, the surface level with its rim is too high for mixing and beating. When a lower surface for mixing and beating cannot be provided, the sink may be set at such a height that the surface level with its top is 31½ in. above the floor. This of course makes the bottom of the sink too low for comfort in washing dishes, but the dishpan may be set upon the mixing surface while dishwashing is in progress.

From the studies cited above, it seems clear that the best height for the bottom of the sink is 32½ in., with a drainboard whose height will be determined by the level of the top of the sink, provided that other built-in work surfaces not more than 32 in. from the floor are available.

There is no objection to a double drainboard unless space is limited so that the double drainboard leaves too little room for a counter or a movable table provided by the tenant for mixing and beating. When the amount of space available is restricted, the range top or the table or counter for mixing and beating may be placed at the right of the sink and serve as a stacking surface for soiled dishes.

The modern streamlined kitchen with a counter into which a sink is set occupying all the wall space not taken up by doors, range, and refrigerator does not provide the best conditions for work but is preferred by many on esthetic grounds.

Where laundering is done on the premises, a laundry tub and available drying facilities are essential. In multiple-dwellings, common laundries should be provided if it is probable that they will be used by the prospective occupants.

The convenient disposal of garbage and refuse is important for many reasons, including control of flies, rats, and other vermin which may spread disease, and avoidance of fire hazards, as well as for the maintenance of self-respect. In congested areas, a sanitary non-absorptive receptacle for garbage is an essential part of house equipment, and in multiple-dwellings special chutes discharging into incinerators have been found desirable. The best type of outside garbage receptacle is one that is set below the ground surface and protected from access of animals. A separate receptacle for ashes and rubbish should be provided where necessary, protected against dissemination of its contents by the wind.

Principle 13. Provision of facilities for maintenance of cleanliness of the dwelling and of the person

a. *Specific Requirements* — Cleanliness of the dwelling depends in part on such construction as will facilitate cleansing: both dwelling cleanliness and

personal cleanliness demand an ample supply of water (20 gallons per capita per day is a minimum for household use), with facilities for heating water. The ends in view are justified in part by the rôle of clean hands in preventing the spread of germ diseases, but on an even wider base they may be considered essential to self-respect from a psychological standpoint.

b. *Methods of Attainment*—To facilitate household cleansing, interior surfaces should be as nearly impervious, and joints between surfaces as tight, as is reasonably practical. Design should minimize dust-catching angles and pockets. Surfaces should be readily washable.

A safe water supply, adequate in quantity and under pressure, should be available within the dwelling. Where water has to be brought in by hand it will not be used in amounts necessary for cleanliness. Anything short of a pressure supply is a sub-standard compromise.

A bathtub or shower should be provided for each family where a pressure water supply is available, in addition to a wash basin.

Finally, at least a minimum supply of hot water is an essential of sanitary decency. This may be provided in the very low-cost rural home by heating water on the stove, but a hot-water heater is a basic element in really satisfactory housing.

Principle 14. Provision of possibilities for esthetic satisfaction in the home and its surroundings

a. *Specific Requirements*—It is obvious that matters of taste cannot be crystallized in quantitative terms, but the desire for beauty is a fundamental urge whose satisfaction is essential to healthy living in the full sense of the term.

b. *Methods of Attainment*—The attainment of this end is dependent not on ingenuity in decoration or ornamentation, but on fundamental design and grouping of buildings in relation to the site and to each other, with due reference to the fact that variety is no less important than harmony.

Above all else it is essential that the buildings be placed and massed so as to give a sense of spacious openness and to conserve existing features of natural beauty. Simple landscape treatment, designed for low maintenance costs, can meet this requirement with no unreasonable burden on the rental scale.

Exterior beauty of buildings is best attained by rational design, simple harmonious masses, fresh colors, interesting wall-textures, well studied placement of windows in relation to their function—devices all of which depend more on skill than on expense—rather than by surface ornament, which is generally aimless, costly, and superfluous, and a confession of esthetic bankruptcy on the part of the designer.

Interiorly, the need is for harmonious settings for daily life, with as much freedom as possible for esthetic self-expression. Among the means available to the skillful designer are well proportioned floor and wall spaces, windows and doors so placed as to present attractive vistas, and appropriate color schemes. Although meaningless ornament and mouldings are best omitted, reasonable provision should be made for hanging pictures and draperies. The dwelling as provided by the designer should not be regarded as a finished or static thing, but rather as a flexible background for living.

Principle 15. Concordance with prevailing social standards of the local community

a. *Specific Requirements* — Requirements here are obviously purely relative. It should, however, be pointed out that the sense of inferiority developed in a home notably below the

standard of friends and neighbors may, and often does, produce emotional reactions, particularly in children, which are fundamentally incompatible with mental health. The public has developed a keen sensitiveness to the dangers of communicable disease, but still fails to realize the importance of emotional hazards. Under modern conditions of American living, a sense of inferiority due to living in a sub-standard home may often be a more serious health menace than any insanitary condition associated with housing.

b. *Methods of Attainment* — These again are relative and cannot be stated in any general terms. It is important that housing plans should take into account local social and racial standards which may profoundly modify the applications of the principle under discussion.

Social standards of a given area should be protected by proper zoning ordinances.

Control of the environment in the interest of community well-being has long been practised in the protection of communal water supplies and the prevention of communicable disease. The modern community must extend this control to cover sources of social contagion as well. Unregulated saloons, poolrooms, commercial dance halls, etc., may have mental hygiene effects, particularly on adolescent youth, quite as serious as the analogous physical effects of failure to control disease. Such potential sources of social contagion should be rigorously excluded from the modern housing development, and in so far as possible from its vicinity.

SECTION C

Protection Against Contagion

Principle 16. Provision of a water supply of safe sanitary quality, available to the dwelling

a. *Specific Requirements*—The water supply system should be so located, constructed, and operated that the water supply will not be a means of conveying disease; and the water should be devoid of objectionable chemical and physical characteristics. In some localities, it may be impossible to obtain water that meets all of these requirements, but in any case only a water that is safe from a public health point of view should be used. The U. S. Treasury Department standard for interstate-carrier water supplies may be used in determining safety. The U. S. Public Health Service is now preparing a water supply code which should serve as an excellent guide in water supply sanitation.

b. *Methods of Attainment* — The ideal is, of course, a communal supply which is approved by health authorities. The availability of such a supply should be an important factor in selecting sites for housing projects.

Where individual supplies are the only ones obtainable, a properly protected spring or well is ordinarily the best solution of the problem. Surface supplies cannot practically be made safe for the individual household. The conditions necessary to insure a sanitary well supply are outlined in the Progress Report of the Committee on Ground Water Supplies of the Conference of State Sanitary Engineers for 1936, published as Supplement No. 124 of *Public Health Reports* (U. S. Public Health Service).

Principle 17. Protection of the water supply system against pollution within the dwelling

a. *Specific Requirements*—This principle requires construction of house plumbing in such a way that the water cannot be contaminated by cross-connections, by siphonage from bowls, tubs, or toilets, or by drip into water reservoirs.

b. *Methods of Attainment* — Direct cross-connections or contamination of water reservoirs can be avoided by proper initial construction and by routine inspection of large installations by health departments to check on alterations. To avoid one common and possibly serious source of contamination—back-siphonage of polluted water into the supply—all fixture inlets which are directly connected to the supply system should be at a sufficient distance above the possible water level attained in the fixture itself to prevent contact. Numerous types of lavatories, drinking fountains, and other fixtures now in common use (and even some of those installed in recent public housing projects) violate this principle, although safe equipment is on the market.

There are available devices for the protection of existing fixtures which, when properly installed, afford a considerable degree of protection. Many such fixtures may be protected with very little labor or expense. All new plumbing installations, whether in new or old buildings, should be free from defects of all kinds which may permit water contamination to occur.

Suggestions for meeting the above conditions are given in the report of the Joint Committee on Plumbing of the Conference of State Sanitary Engineers and the American Public Health Association, published in the 1938–1939 *Yearbook* of the A.P.H.A.

Principle 18. Provision of toilet facilities of such a character as to minimize the danger of transmitting disease

a. *Specific Requirements*—This principle involves, on the one hand, prevention of spread of infection by flies or other insects and, on the other, reduction of the likelihood of transmitting intestinal or venereal diseases by contact.

b. *Methods of Attainment* — The ideal method of controlling access of insects to fecal discharges is the water carriage system of sewerage, and housing projects should—so far as is possible—be located where such facilities are available. For the isolated home where water carriage is impossible, a sanitary privy so constructed as to protect fecal deposits from access of flies, and so located as not to endanger a water supply, is obviously a minimum essential. The type of privy recommended by the U. S. Public Health Service may be used where this method of disposal is unavoidable.

A separate toilet for each family would seem to be essential to insure responsibility for cleanliness as well as to promote decency.

Toilets should be located at a sufficient elevation above the sewer level to avoid back-flooding.

From the standpoint of avoiding venereal disease transmission, the toilet seat should be of an open-front type.

To avoid dangers of infection from contact with fecal matter, the walls and floor of the toilet compartment should be of material which is as nearly impervious as possible. Good lighting of the compartment is essential, since visibility is a major factor in stimulating habits of personal cleanliness. Artificial lighting alone is unsatisfactory on account of maintenance problems; a window opening to the outer air should be considered a minimum essential for all new construction.

If the toilet compartment has a window opening to the outer air, no special

provision for ventilation is necessary. Furthermore, many plumbing codes require quite unnecessary construction costs. The *Recommended Minimum Requirements for Plumbing* published by the National Bureau of Standards in 1931 should be used for the revision of obsolete plumbing codes.

Principle 19. Protection against sewage contamination of the interior surfaces of the dwelling

a. *Specific Requirements*—This principle involves tightness of the house drainage system and construction of the main house drain and the external sewerage system so as to avoid back-flooding.

b. *Methods of Attainment*—Leaks of sewage on cellar floors, work surfaces, or elsewhere can be avoided by tightness of construction. To prevent the backing up of sewage into the dwelling, care should be exercised in selecting sites where adequate sewage disposal facilities are, or can be provided. Preference should be given to locations where separate systems of sanitary and storm sewers are available and to locations where ample fall can be obtained between the basement floor of the dwelling and the street sewer. Where such separate systems are in use, storm water from the roof and surface drainage should be conducted to the storm water sewer, and only domestic sewage and basement drainage allowed to enter the house sewer. Where necessary, the hazard of back-flooding the basement may be minimized by (1) installing an automatic back-water valve and a gate valve on the branch drain to which basement plumbing fixtures are connected, or (2) connecting the outlets of basement plumbing to a sump equipped with a suitable automatic electrically-driven pump or compressed-air ejector which is arranged to discharge into the building sewer, stack, or street sewer. Water-operated sump pumps or ejectors should not be used, since they may involve a very serious cross-connection between the sewer and water supply piping.

In the case of an isolated dwelling which is provided with an individual sewage disposal system, only domestic sewage and basement drainage should enter the system.

Principle 20. Avoidance of insanitary conditions in the vicinity of the dwelling

a. *Specific Requirements* — Where a cesspool or local sewage disposal plant is maintained, it must be so designed and operated as to avoid exposure of sewage which will permit transmission of disease by contact, by flies, or by pollution of wells; and the neighborhood must be kept free from accumulations of refuse which will afford food or harborage to flies or rats, and from standing water in which mosquitoes may breed.

b. *Methods of Attainment* — Where a cesspool or a local sewage disposal system is used, certain principles concerning the location and construction of such installations should be observed (such as location and depth of sewer; pipe sizes, materials, and jointing; and location, capacity, and covering of tanks). State health departments usually provide specifications in regard to these points. This committee has prepared suggested minimum standards for the location and design of sewage disposal systems for isolated dwellings where a settling tank and soil absorption system is used.* The possibility of contaminating wells through the soil should be avoided in locating privies and sewage disposal systems. (Particularly in clay or limestone regions, possibilities of safe sewage disposal for the population involved should be considered in choosing a housing site.)

* *Public Health Reports,* 53:906–909 (June 3), 1938.

Accumulations of organic refuse which will breed flies should be avoided by provision of facilities for the removal and disposal of such refuse. Accumulations of rubbish, piles of lumber, etc., may provide harborage for rats and should not be permitted.

Stagnant water should, where possible, be removed by drainage or filling; bodies of water which cannot be removed and which are of a character to permit mosquito breeding should be treated by appropriate anti-larval methods.

Principle 21. Exclusion from the dwelling of vermin which may play a part in the transmission of disease

a. *Specific Requirements*—This principle is concerned primarily with protection against mosquitoes, flies, and rats.

b. *Methods of Attainment* — Where mosquitoes and flies are present, all doors, windows, and other openings should be screened with No. 16 wire mesh. Screen doors should always open outward and should be self-closing. It is desirable to screen an entire window rather than only a part of it.

Where the rat problem is appreciable, care should be taken to close effectively all openings through foundations and floors, as, for instance, those around pipes and cracked walls. Such openings should be closed with metal sheeting or concrete or other suitable ratproofing material, such as asbestos board. Basement windows should be covered with strong, durable screening, such as standard 8-mesh galvanized hardware cloth. Ventilators and sewer openings should be provided with gratings. Exterior doors should be self-closing. The building foundation should be of concrete or masonry (or otherwise rendered rat-proof) and should extend (aside from frost or structural load considerations) from a point at least 2 ft. below ground to a point at least 2 ft. above ground. In case the floor is closer to the ground than 2 ft., the space in the walls between the studding should be filled with concrete, or other material indestructible by rats, up to a point 2 ft. above ground level.

Where the population to be housed is likely to be infested with vermin, provision may have to be made for fumigating clothing and furniture before occupancy is permitted.

Principle 22. Provision of facilities for keeping milk and food undecomposed

a. *Specific Requirements* — Various bacteria which cause food poisoning may propagate in foods which are not adequately cooled. Every home should have facilities for holding perishable foods at 50° F. or below.

b. *Methods of Attainment*—Either a mechanical refrigerator or a suitably constructed ice refrigerator should be considered an essential element in home equipment. Even in northern climates this will be necessary in summer. The amount of refrigerated food storage space desirable for urban homes depends upon the food habits of the family and upon the marketing practices of the housewife. A minimum of 4 cu. ft. per family will suffice, however, for the essential needs of most urban households.

Drains from ice refrigerators should be completely disconnected from sewers and other waste lines; there should be an air gap of not less than 1 in., measured vertically, between the ice refrigerator drain and the rim of the fixture into which it discharges.

Principle 23. Provision of sufficient space in sleeping-rooms to minimize the danger of contact infection

a. *Specific Requirements* — Experience in barracks and institutions has shown that a distance of less than 6 ft. between the centers of adjoining

cots or a space of less than 50 sq. ft. per bed may lead to the spread of communicable diseases by dissemination of mouth spray from an infected occupant. The distance of 6 ft. between the centers of adjacent army cots would imply at least a 3 ft. space between the beds themselves, which is the essential point.

b. *Methods of Attainment*—To make it possible to meet the requirements above, the sleeping-room should therefore have approximately 50 sq. ft. of floor space per occupant. This amount of space will also be generally required for placement of the customary bedroom furniture. With ceiling heights ranging from about 7 ft. 8 in. to 8 ft., such sleeping-rooms will check satisfactorily with the requirement of 400 cu. ft. of space per occupant specified in Principle 3.

Double-deck beds, sometimes advocated as a space-saving device, are undesirable as favoring mouth spray infection.

SECTION D

Protection Against Accidents *

Principle 24. Erection of the dwelling with such materials and methods of construction as to minimize danger of accidents due to collapse of any part of the structure

a. *Specific Requirements*—These are being studied by the Building Code Correlating Committee of the American Standards Association, whose program includes standards for excavations and foundations, masonry work, iron and steel work, and structural loads.

b. *Methods of Attainment* — The ways in which such safety requirements can be translated into practice are obviously too complex to be cited here.

In view of current interest in the problem, a word may be said as to the structural menace of termite infestation. In zones where such infestation is serious, special provision should be made for termite control by constructing foundations of impenetrable concrete or masonry, and by removing stumps, chips, and litter from beneath the house. Adequate ventilation should be provided for the space beneath the house; vents should be screened; the clearance between the ground and woodwork should be at least 6 in. for the outside of the foundation and 18 in. inside; and for the most effective protection, termite shields of copper or other durable metal should cap the foundation wall. For complete protection, these shields should be continuous and extend entirely across the foundation wall, should project 2 in. or more on either side, and should be bent down at an angle of 45°. All posts, piers, pipes, and other structural members in contact with the ground should be shielded with projecting caps or collars. Surfaces that are difficult to inspect should be given the most thorough protection.

Principle 25. Control of conditions likely to cause fires or to promote their spread

a. *Specific Requirements* — All that can be insisted on—from the standpoint of protecting the lives of occupants—is that dwellings shall be so

* The importance of this problem is indicated by the fact that in 1936 home accidents in the United States caused 38,500 fatalities as compared with but 37,800 motor vehicle fatalities.

constructed and equipped as to minimize the probability of starting fires, and that the spread of fires shall be sufficiently retarded to permit the escape of occupants. Local building codes may require that dwellings shall not collapse for a period of several hours under fire conditions so extreme as to preclude the survival of any occupant. Such requirements, which add to the cost of building, must find their justification on other grounds than those of human safety.

b. *Methods of Attainment* — Potential sources of fire within the dwelling exist in electric installations, stoves and furnaces and their smoke-pipes, and in chimneys. Prevention of electrical fires calls for such details of construction as will control danger of crosses and the avoidance of exposed wiring subject to short-circuiting through wear. These factors are adequately dealt with by the usual local electrical codes. Stoves or furnaces should be mounted clear of combustible walls and floors, and if located near woodwork, should be insulated from it by adequate air space and by mats or screens of non-combustible material. Smoke-pipes should be securely supported, well separated from woodwork or other inflammable materials, and kept clean. Where such a pipe must pass through a combustible partition, a ventilated thimble should be used to provide an air space around the pipe. Stove-pipe openings in chimneys should be covered when not in use.

Chimneys should be so constructed and supported as to avoid danger of overheating adjacent combustible elements. Masonry chimneys should be lined with fire-clay tile, with joints staggered in relation to masonry courses. Wood beams, joists, or partition members should be placed at least 2 in. away from chimneys, with the intervening space mortar-filled or otherwise effectively insulated.

In order to prevent the spread of fire originating within the structure, safe practice demands that in multiple-dwellings (regardless of height) the stairways be enclosed by fire-resistive materials, and that in all such dwellings over 2 stories in height the following elements be of fire-resistive construction: exterior walls, roofs, first-tier beams, partitions between apartments and between stair halls and apartments, and all shafts. ("Fire-resistive" materials are meant to include those which upon test show that they will resist fire or delay its spread for a sufficient time to permit the escape of occupants.) It is hardly less desirable that all floors and floor joists also be fire-resistive. All multiple-dwellings exceeding 4 stories in height should have non-combustible floors and floor joists, and all those exceeding 6 stories in height should be non-combustible throughout.

For single-family dwellings of low cost, such fire-resistive construction may not be feasible, but fire hazards should be restricted through care in the installation of stoves, chimneys, and electric wiring as described above, through fire-stopping, and through reasonable precautions in the construction and finishing of roofs and walls.

Where framing with combustible members involves hollow wall spaces, the spread of fire can be retarded by closure of these spaces with fire-stops at the floor, wall, and roof lines. Well fitted boards can serve as temporary checks, but better results will be obtained by filling the voids with non-combustible materials for a distance of 4 in. or more above the fire-stops.

Fires are commonly spread from building to building by brands or radiant heat. Most of the non-combustible types of roofing have sufficient insulating value to prevent ignition of the boards supporting them by either of these means. The protection afforded by metal roofings can be in-

creased by placing asbestos felt between the roofing and the boards. Wood shingles should not be used on account of their poor resistance to brands; once afire, they may themselves give off flying brands and set fire to neighboring structures. Weathered wood shingles are particularly subject to ignition by brands.

Among the common exterior wall materials, the range in fire resistance begins with board finish and runs in order through phenol plywood, stucco on wood lath, stucco on metal lath, and masonry veneer over wood frame, to load-bearing masonry walls. Well maintained paint coatings will slightly increase the fire resistance of a wood surface to exterior fire sources.

It should be a routine requirement that inflammable buildings be spaced far enough apart to prevent the spread of fire by radiant heat.

Fire-fighting provisions which are usually necessary include reasonable accessibility of each dwelling to fire-fighting vehicles and an adequate water supply for fire apparatus. The provision of chemical fire-extinguishers may be justified in the halls of multiple-dwellings.

Principle 26. Provision of adequate facilities for escape in case of fire

a. *Specific Requirements* — In every living-unit, the existence of exits which will not be cut off in case of fire should be regarded as a minimum essential: and these exits should be of such a nature that they can safely be used by women and children and at night.

b. *Methods of Attainment* — Multiple-dwellings should be provided with at least two means of exit from each living-unit. For reasons of economy in construction, exception may reasonably be made in the case of multiple-dwellings of 4 stories or less which conform to *Methods of Attainment* under Principle 25 and are provided with stairways in separate fire-resistive enclosures having self-closing doors at each floor; compromises may also perhaps be made in certain cases of 2 story combustible buildings.

In multiple-dwellings, the doors of public exits should open outward.

Where local ordinances require outside fire-escapes, these should be constructed in accordance with the *Building Exits Code* of the American Standards Association. It is vital that fire-escapes should terminate on solid level ground or pavement in locations from which egress is unencumbered.

It is important to note that many types of drop ladders now permitted by local codes are so heavy and difficult to manipulate (particularly when rusted or heavily painted) that only a trained athlete can be expected to use them. The danger from such devices to a woman or child on an icy night is very serious.

Principle 27. Protection against danger of electrical shocks and burns

a. *Specific Requirements* — The requirements as to structural installations (aside from fire hazards) are two: (1) Live conductors and live parts of electric equipment should not be exposed to contact. (2) Exposed metal enclosures should be grounded so as not to become alive from failure of insulation. Portable appliances and pendent fixtures should be so placed that a person will not simultaneously come in contact with electric fixtures and with plumbing fixtures or other grounded metal.

b. *Methods of Attainment*—In bathrooms, laundries, kitchens, or other spaces where the hands are likely to become wet, electric lights should be controlled by wall switches or pull chains containing insulating links, and any lamp sockets within reach should have non-metallic shells. Convenience outlets in such spaces should be located

so as to minimize the probability of touching plumbing fixtures while using electric appliances. Where it is necessary, because of limited space, to locate switch or convenience outlets within reach from plumbing fixtures, cover plates for such outlets should be nonmetallic. In no case, however, should wall switches be located within reach of an occupant of a bathtub.

Convenience outlets should be located not in baseboards but high enough to be out of reach of creeping infants, which placement also brings them within more convenient access for the user. Any permanently installed electric heater should have a protective grating to prevent contact.

Principle 28. Protection against gas poisonings

a. *Specific Requirements*—The chief toxic substances likely to be associated with the dwelling are carbon monoxide from imperfect combustion in cooking or heating appliances, leaking gas from fixtures, and toxic gases from certain refrigerating devices. The control of such hazards is obviously essential.

b. *Methods of Attainment*—Any gas cooking-ovens and space heaters which involve the possibility of partial combustion must be provided with an adequate flue opening to the outer air. Chimneys, furnaces, and stovepipes should be maintained in tight and clean condition, as should gas connections and gas heating appliances.

Where toxic gases are employed in multiple refrigerator installations, special attention should be paid to tight and durable jointing, and a warning gas should be added to odorless toxic refrigerants (in replacing routine leakage as well as in the original installation). Rooms which contain gas cooking appliances or mechanical refrigerators should not be used for sleeping.

Precautions against carbon monoxide poisoning in a domestic garage are obviously essential, but ordinarily involve no special structural provisions.

Principle 29. Protection against falls and other mechanical injuries in the home

a. *Specific Requirements* — Hazards of this type are too diverse to be catalogued, but it is clearly essential that stairs, windows, and balconies should be so constructed as to minimize danger of falls. In view of the many serious falls which occur in the bathtub, this problem should be kept in mind in planning the bathroom. Protection should also be given against injuries on outside steps and walks.

b. *Methods of Attainment*—A stairway should not be made too steep, and a proper proportion should be maintained between the dimensions of riser and tread. Satisfactory values are 7 to 7½ in. for the riser and 10 in. for the tread. In any case, these values should meet the conditions that the sum of the tread and twice the riser equals 24 to 25 in., and that the angle of slope is between 30° and 36°. Steps of a flight should be uniform in dimensions, as any irregularity may cause tripping.

It is essential to provide every flight of stairs with a handrail. Outdoor steps especially need rails in northern latitudes, because of ice.

Winding stairways too narrow for foothold at the rail side must be avoided, as they particularly invite falls. If a doorway is placed at the head of a flight of stairs, which practice has merit from the standpoint of preventing the spread of fire, there should be a landing at least 30 in. wide on the stair side of the door. If this landing is omitted, the door should have a glazed window.

Low window sills (less than 30 in. from the floor) should be avoided, especially at stairway landings. If unavoidable, low windows may be pro-

vided with one or more cross-bars to prevent children from falling out. Built-in window screens have advantages, from the casualty prevention viewpoint.

Casement windows, if designed with sufficient clearance at the hinge to permit washing from the inside, will minimize dangers in window cleaning.

There should be railings or parapets around porches, balconies, accessible roofs, etc., high enough (at least 30 in.) to prevent falling off the edge. Such falls may cause serious accidents even when the distance is not more than 2 or 3 ft.

In bathrooms, especially where built-in tubs are installed below tiled walls, built-in hand-grips should be provided, sufficiently in front of the bather's position to be within convenient reach.

In the North, sloping roofs (with a pitch of perhaps from 15° to 55°) which end over steps or walks should be equipped with snow guards to prevent masses of snow from sliding onto the head of the passerby.

Adequate lighting of exterior courts, walks, and particularly of steps, is an essential safety factor.

Principle 30. Protection of the neighborhood against the hazards of automobile traffic

a. *Specific Requirements* — Attainment of this ideal must obviously be relative, and no specific standards can be set.

b. *Methods of Attainment* — Traffic regulation is an essential element in modern community planning; and it is particularly important that traffic in the vicinity of dwellings should be so organized as to minimize danger to both motorists and pedestrians (particularly children).

Residential streets should therefore be so planned as to discourage through traffic. It is often possible to do this in new housing communities by means of dead-end streets. Blind corners should be avoided by proper study of placement of both the buildings and shrubbery.

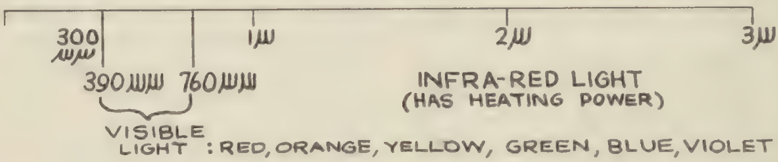
Pedestrian routes from all residential areas should be so planned that elementary schools, local shops, playgrounds, etc., may be easily reached without crossing any major traffic way except by the use of overpasses or underpasses.

Playgrounds should be effectively screened off from automobile ways.

For regulations regarding tourist and trailer camps, schools, hotels, lodging houses and boarding houses, see specific requirements as set up in the Sanitary Code of Louisiana.

Lighting

Poor lighting is a causative factor in producing defective vision, increasing accidents, and decreasing ability to work quickly and efficiently.
Sunlight is the best type of lighting, although artificial lighting is becoming more and more developed in approaching the efficiency of natural light.
The sun gives off wave lengths which measure from 300 millimicrons to 3 microms. A microm (whose symbol is μ) is a millionth of a meter or a thousanth of a millimeter. A millimicron (whose symbol is $m\mu$) is a thousandth part of a micron.
Visible light waves range between 390 millimicrons and 760 millimicrons.



Sunlight is composed of: 1 - 5% -- ultra-violet waves, 41 - 45% -- visible waves, 52-60% -- infra-red waves.
The percent of ultra-violet waves in sunlight varies with: (1) altitude, (2) latitude, (3) humidity, (4) temperature, (5) season, (6) time of day.

Ultra-violet is greater in areas beyond the torrid zone.
Infa-red waves are 10% greater in summer midday sun than in winter midday sun.
Red waves are 45% greater in summer midday sun than in winter midday sun.
Green waves are 90% greater in summer midday sun than in winter midday sun.
Blue-violet waves are 250% greater in summer midday sun than in winter midday sun.
Ultra-violet waves are 1000% greater in summer midday sun than in winter midday sun.

Water, sand, snow and clouds reflect ultra-violet waves.
Sand reflects much infra-red waves.
Snow reflects little infra-red but much ultra-violet waves.

Excessive ultra-violet light affects the eyes by causing conjunctivitis, inflamation of the cornea, necrosis of the retina and eventual blindness. The formation of cataracts in the eyes is one of the causes of blindness. Snow blindness and blindness of welders are produced in this manner.

MEASUREMENT OF ILLUMINATION

Candle Power is the unit of intensity of a light source. One candle power is equal to the total amount of illumination given off by a (standard) candle. One watt produces approximately one candle power.
Foot Candle is the unit of intensity of illumination on a surface. One foot candle is equal to the intensity of illumination produced by one (standard) candle on a surface one foot away. The intensity of illumination on a surface varies inversely with the square of the distance from the source of light.
Brightness is defined in two ways: (1) Brightness of light source or intrinsic brilliancy is the candle power per square inch of light source. (Up to 2.5 candle power per square inch of source is comfortable to eyes; 4000 C.P. per sq. inch is very uncomfortable; 1,000,000 C.P. per sq. inch is harmful). (2) Brightness of reflecting surface or the apparent foot candles, is the foot candles of illumination on a reflecting surface. This is usually less than the brightness of the light source because the surface will usually absorb some of the light.
There are two ways of measuring illumination in a practical manner: (1) Photoelectric cell which measures the intensity of light by transforming the light energy to electrical energy. (2) Foot candle meter - which measures the intensity of the light by comparing a standard intensity on a screen with the reflected light from the light source on a proximal screen.

Contrast is defined as a ratio between the "brightness difference" and the "brightness of the lighter surface". By brightness difference is meant the difference between the brightness of light reflected from the background of any object and the brightness of the reflected light from the object itself. For example, if any surface reflected all the light that strik

it, then the brightness of the surface is 100%. Now suppose that the brightness of the light striking a white paper were 100 foot candles. Let us assume that this white paper (which is the background) reflects 80 footcandles of the illimination, and the black print on the paper (which is the object) reflects 5 footcandles of the illumination. Thus the lighter surface reflects 80% of the light and the darker surface reflects only 5%. The difference between the percent of light reflected from the lighter surface and the percent of light reflected from the darker surface is 75%, and this is called the "brightness difference". By definition the contrast would be the ratio between 75 and 80, i.e., 75/80. Thus, there is a contrast in this case of 94%. Now, if the paper reflected only 50% of the light, then the contrast would be decreased to 90%, i.e., 45%/50% = 90%. The reduction of contrast makes vision more difficult, and coupled with reduction in brightness, the difficulty is multiplied.

Visual acuity increases with increased illumination. It increases rapidly up to 5 footcandles, gradually from 5 to 10 foot candles, very slowly from 10 to 20 foot candles, and over 20 to 25 foot candles there is practically no increase in acuity of vision.
As age increases, greater illumination becomes necessary.
The less the contrast, the greater the illumination necessary to see an object (or to increase visual acuity).
Speed of vision increases with increased illumination.
The muscles of the eye (ciliary muscles) strain themselves, when illumination is decreased, in attempting to increase visual acuity. Eye fatigue increases quickly below 3 foot candles of illumination.
In case of defective vision, or fine detailed work, or lack of contrast, the foot candles of illumination should be much higher than for normal conditions.
If one works where it necessitates going from daylight to artificial light very often, the artificial light should have greater foot candles of illumination than normally.
The contrast between the field at which one looks and the surrounding field should be very small.
There should not be a bright spot in the field of vision.
Next to sufficient illumination, control of glare is the most important factor for good vision.
Glare depends upon: (1) the intrinsic brilliancy of the light source, (2) the distance of the light source from the eye, (3) the angle of the light source producing glare on the eye. Light must be on the work and not in the eyes. The nearer the light source to the line of vision, the greater the glare. At an angle of 10 degree, a 100 watt lamp produces as much glare as a 225 watt lamp at 15 degree above the line of vision. A light 30 degrees above the line of vision is practically glareless.
Discomfort from glare is due to the effort of the eyes trying to accomodate to two different intensities of light at the same time, i.e., the bright source and the surrounding lesser brightness. Whether it is retinal or pupillary accommodation is unknown.
Glare may be due to direct or reflected light.

Reflected Light - Light which strikes any surface is either absorbed or reflected. The light which strikes the surface is known as the incident light and the light which is returned from the surface is known as the reflected light. It is the latter which gives brightness to a surface which itself has no light source. The ratio between reflected light and incident light is known as the reflection factor or coefficient of reflection. Thus, if a surface reflects 80% of the incident light, 80/100 or .80 is the reflection factor or coefficient of reflection. Therefore the brightness of an illuminated surface divided by the reflection factor will be equal to the intensity of illumination. Thus, in the above example, if the brightness of the illuminated surface is 80 foot candles, then 80/.80 or 100 foot candles would be the intensity of illumination.
Light is reflected in several ways. If it strikes a mirror the reflected rays remain parallel. This is known as specular reflection. Light which strikes dull, white paper or a white powder has its rays scattered to all possible angles. This is known as diffused reflection. Reflected light made up of a combination of both specular and diffused reflection is known as composite reflection.
Reflection resulting from wall and ceiling surfacea is very important in illumination of rooms. Of light which strikes walls or ceilings, part is absorbed and the balance is reflected to strike other surfaces where more will be absorbed and the balance reflected, and so on until all the light is absorbed. Each reflection contributes to illumination over that of the lamp alone. Therefore ceilings, walls, and floors of low absorbing and high reflecting powers aid materially in illumination. The lighter colors reflect more light than the darker ones, black being completely absorbent unless the surface is highly glazed or polished in which case there will be some specular reflection.

Reflection Factors of Paints of Various Tints (1)

Classification	Reflection Coefficient Per Cent	Classification	Reflection Coefficient Per Cent
Gloss mill white	74 to 82	Light buff	58
Flat mill white	78	Light green	47
Light cream	74	Light gray	49
Light pink	67	Medium blue	36
Light yellow	65	Medium gray	30
Light blue	61	Red	13

Diffuse light producing no shadows is desired ordinarily. In printing work shadows are required because the relief print can only be distinguished by shadows.
With as little as .1 foot candle, a printed page can just be discerned.
For protracted reading not less than 10 foot candles should be used and as high as 25 foot candles is desirable.
For auditoriums 5 foot candles are adequate.
There is a tendency, at present, to recommend greater illumination than in the past. The following table of school lighting requirements although recommended in the past may be somewhat below the standards that are presently being recommended.

School-Lighting Requirements (1)

	Recommended Foot Candles	Minimum required Foot Candles
On the space:		
Walks, drives, and other outdoor areas, if used at night	0.5	0.1
Playgrounds, outdoor, if used at night	2.0	0.5
Playgrounds, outdoor, if used at night for basketball, baseball, etc.	10.0	5.0
Storage spaces, passages, not used by pupils	2.0	0.25
Boiler rooms, power plants, and similar auxiliary spaces	3	1
Stairways, landings, corridors, aisles, exits, elevator cars, washrooms, toilets, locker spaces, dressing rooms	3	1
Recreation rooms, gymnasiums, swimming pools	7	3
On the work:		
Auditoriums, assembly rooms	3	2
Auditoriums, assembly rooms if used for class or study purposes	10	5
Classrooms, studyrooms, (at desk tops)	10	5
Classrooms, studyrooms (at charts,blackboards)	6	3
Libraries (reading tables, catalogs)	10	5
Libraries (bookshelves, vertical plane)	6	3
Laboratories (tables, apparatus)	10	5
Manual training rooms, workshops, etc.	10	5
Drafting rooms, sewing	15	8

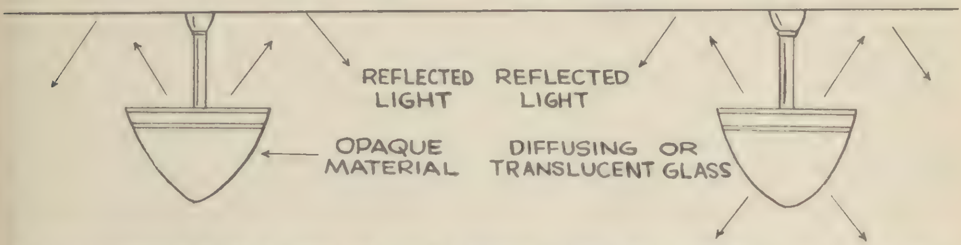
6 foot candles of illumination is recommended for trains
8 " " " " " " " churches, hotel lobbies
10 " " " " " " " banks
12 " " " " " " " reading rooms
15 " " " " " " " barber shops
20 " " " " " " " art galleries
5 " " " " " " " casual seeing
10 " " " " " " " factories
20 " " " " " " " clerical work
50 " " " " " " " watch repairing
100 " " " " " " " sewing dark goods

TYPES OF ARTIFICIAL LIGHTING SYSTEMS

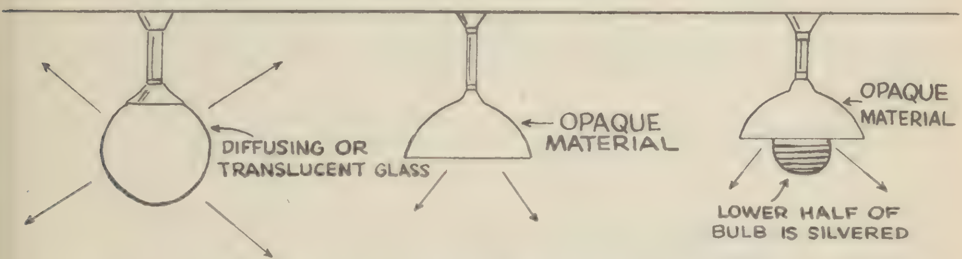
In spite of the great strides which artificial lighting has made in late years and the difficulties sometimes encountered in obtaining effective natural light, the latter will be the standby for homes, schools, offices and even in industrial lighting where possible.
"Daylight" artificial light gives no better illumination than regular yellow light. It does aid in distinguishing colors and is much cheaper to operate. Fluorescent light is produced by passing an electric discharge in a tube of gas. Sodium gas produces yellow light,mercury gas produces blue light, and neon gas produces red light. Ultra violet light waves acting on a fluorescent substance causes the ultra-violet waves (invisible) to change to visible light. This type of lighting is very efficient since less of the energy is consumed in producing heat and more in producing light. A 15 watt fluorescent light gives the same

lighting effect as a 60 watt incandescent lamp.
There are five types of artificial lighting systems: (1) Totally indirect, (2) Semi-indirect, (3) Semi-direct, (4) Direct, (5) Direct and indirect.

1. Totally indirect lighting units are the best. They produce no glare and the least tiredness and discomfort to the eyes. It gives the poorest efficiency of light per unit of electricity, and is the most difficult to maintain due to dust collection by the fixtures and the necessity of always maintaining a very light colored and clean ceiling. The ceiling should not be shiny. There is a limit in increasing the number and power of light bulbs in indirect lighting, because at a certain point, glare spots are produced on the ceiling.



2. Semi-indirect lighting units are used in schools. They give more efficiency than totally indirect lighting but produce more glare and more discomfort.



3. Semi-direct lighting units are of greater efficiency than semi-indirect lighting units, but produce more glare and greater discomfort, though less expensive to maintain. These units are used in kitchens, halls, gymnasiums, etc. The bulbs are completely enclosed.
4. Direct lighting units are of greatest efficiency but produce more glare and more discomfort than any of the lighting units. They are least expensive to operate and are used in basements, laboratories, shops, etc.
5. Direct and indirect lighting units are very efficient, produce less glare than direct lighting units and are effectively used in factories.

SCHOOL LIGHTING

Poor illumination in school rooms may be a very important factor in causing defective vision and consequent low-grade scholarships among the children; therefore this item must be scrupulously examined. Light should enter the school room from the left side in order that shadows of the hand, pen, and pencil should not fall upon the paper while writing. Thus the desks in the room should always be arranged so that the children's left hands will be nearer the windows. Right sided entrance of light is never satisfactory, and light entering from behind the teacher who usually faces the pupils is not permissible. In order for the sunshine not to cause glare, the school room should be illuminated from windows occupying only one side of the room. The glass area of the windows should extend to within 6 inches of the ceiling in order that the far corners of the room may receive as much natural day light illumination as possible; and in order to prevent glare, they should not extend forward beyond the front rows of desks. Each window should have translucent shades, operated from the middle of the window up and down permitting independent control of sunshine through the upper or lower half of the window. The maintenance of clean walls is of utmost importance since dirt absorbs the light. The width of a classroom should not be more than 24 feet, for otherwise impracticable high ceilings would be necessary in order to allow the light that reaches the right side of the room to be sufficient. A ceiling 13 feet high would under ordinary circumstances give sufficient light in a room 24 feet wide. Light entering the upper one-third of the window is as effective as the light from the lower two-thirds. Dark colored walls and ceilings should be avoided, as the illumination is then more apt to introduce glaring contrasts besides reducing the lighting efficiency. Flat white,

cream, tan or light green are preferable colors. White is more tiring to the eyes than the other three colors. The effect of low bottomed windows has a tendency to produce glare on the opposite walls, and may be neutralized by painting the lower three or four feet of the walls brown or dark green.
The optimum light in a school room is between 15 and 25 foot candles. This means that every desk and all the blackboards should have this amount of illumination. High illumination has a tendency to stimulate the pupils and make them more attentive; subdued illumination is conducive to restfulness and inactivity. Because daylight is not a constant quantity, the ideal schoolroom should have supplementary artificial lighting. No light in a room should be too brilliant; the maximum brightness should not exceed 300 foot candles; no tungston lamp should exceed 100 watts. Semi-indirect lighting is the most satisfactory artificial illumination for a school room. In a light colored room, from 1 to 3 watts per square foot of floor space will supply from 10 to 30 foot candles of illumination. With proper diffusion, artificial light in any practicable amount is harmless. Lights are best located on the ceiling. Wall lights usually throw shadows, and if not at least 30 degrees above the line of vision,they will produce a glare. As glare increases, it produces successively distraction, discomfort, fatigue, and reduced visibility. On blackboards, some of the writing is often invisible from a part of the school room because of the glare of reflected light. If good greenish-black slate is used, cleaned regularly with coal oil and resurfaced when old, this handicap is readily controlled. Tilting the blackboards forward and adjusting the translucent shades or venetian blinds will also aid in controlling glare.

A simple method of calculating the approximate brightness of artificial light is as follows: On a white horizontal surface one foot below a tungston lamp the brightness produced is about one foot candle per watt, and decreased by the law of the inverse square. Therefore if the white surface is 3 feet away from the lamp, the brightness will be 1/9 as bright if 4 feet away, the brightness is reduced to 1/16.
In school rooms where home economics, woodwork, or machine work is taught, the light must be greater than in the other rooms.

Lamps, glassware, and window-panes must be kept clean. Dust and dirt can cause a decrease in lighting efficiency of from 10 to 40%. Water is cheaper than watts.

References: (1) Municipal and Rural Sanitation - Ehlers and Steel
(2) Rural Health Practice - Mustard
(3) Preventive Medicine and Hygiene - Rosenau
(4) The Effect of Illumination on the Eyes - National Better Light-Better Sight Bureau
(5) Housing for Health - American Public Health Association.

Sanitary Aspects of Air-Conditioning

Heating, ventilation and air-conditioning are subjects so closely related in certain phases that their overlapping forces us to consider them together. The engineering aspects of these subjects will be left for the consideration of the engineer and here only general principles and the less technical phases will be treated.

Definitions: The definition of ventilation has been variously given. That subscribed to by the American Society of Heating and Ventilating Engineers is that ventilation is the process of supplying or removing air by natural or mechanical means to or from any space; it refers to quantity but not necessarily to quality of air. In this sense ventilation is the restricted term while air-conditioning is the general concept. The definition of ventilation bearing the general concept of quantity and quality of air is adhered to by some public health engineers, that is, that it is the art of maintaining in enclosed spaces an atmosphere that is comfortable and free from harmful factors. It really makes no difference which definition is adhered to, so long as one is consistant in his terminology. If one treated ventilation as the limited concept, then air-conditioning, conceived as the general concept is defined as including not only ventilation, but also simultaneously the control of temperature, humidity, air movement, and puity, that is, quality of air.

Composition of Air: Nitrogen - 78.1% by volume, oxygen - 20.9% by volume, carbon dioxide - 0.04% by volume, argon - 0.9% by volume, other gases - 0.06% by volume.

The results of human occupancy of enclosed spaces: (1) Oxygen slightly decreases due to respiration, (2) carbon-dioxide slightly increases due to respiration, (3) organic matter increases from nose, mouth, skin and clothing, usually detected as odor, (4) temperature increases due to the giving off of body heat, (5) humidity increases due to moisture from the lungs and perspiration from skin.

Effect of heat on the body: When the external temperature rises the small arteries and capillaries of the skin dilate bringing more blood to the surface of the body in order to cool the temperature of the body. This is a defense mechanism of the body to prevent overheating. This increased blood in the outer surface of the body causes a fall in blood pressure. At this point another defense mechanism of the body comes into play in order to maintain an adequate blood pressure. In order to do this, the heart rate increases and drives blood faster through the skin. In this way more heat is given off from the body. The body can compensate in this manner up to a certain temperature, beyond which the defense mechanism is thrown out of order. When this happens, the heart rate will increase from 14 to 20 beats per minute for each degree rise in temperature while the body is at rest, and 20 to 25 beats per minute for each degree rise while the person is standing. The respirations correspondingly increase; the metabolism increases also. When the heart rate rises around 130 beats per minute the person feels uncomfortable; when it reaches around 160 beats per minute the person feels very uncomfortable; if it rises higher, the heart and blood vessels fail to adjust themselves to the temperature and the blood pressure falls throwing the person into a condition known as heat exhaustion.

Heat stroke or sun stroke is another condition caused by over heating and failure of the heat regulating center of the central nervous sytem to perform adequately causing an excessive rise in temperature of the body. Heat cramps are due to muscular pain from loss of body salts through perspiration. Taking salt by mouth will prevent or cure this condition.

The amount of evaporation from the skin depends on: (1) Humidity in the air (increased humidity decreases evaporation of sweat), (2) Temperature of the air (the higher the temperature the more moisture it can hold), (3) Air movement (the greater the air movement the more the evaporation).

Effects of cold on the body: (1) Increase loss of body heat (within certain limits this is compensated for by increased heat production of the body and decrease of blood circulation in skin), (2) Decrease of heart rate, (3) Decrease skin temperature, (4) Increased blood pressure, (5) In extreme cases, unconsciousness and death will result.

Moderate variations in temperature are beneficial. Extreme heat or cold and extreme sudden changes of temperature appear to be harmful. Hygienic practices should include protection against or compensation for such extremes.

Carbon Dioxide and Oxygen

CO_2 can be increased to 2% (normal being .04 to 1%) without discomfort. It can rise to 8% before real discomfort. It takes about 40 to 50% CO_2 in the air to cause death. CO_2 never causes death in crowded conditions. In most crowded rooms there is usually not more than 1 to 2% of CO_2.

Discomforture of crowding is not due to decreased O_2 and increased CO_2, but to physical conditions of the air which causes a decreased ability of the body to cool itself. These factors are temperature, humidity, radiant heat, and air movement, and they are affected by: (1) Clothing - this prevents air movement at the surface of the skin, radiation of heat from the body, and cooling by evaporation. (2) Sex & Age - Young boys and men prefer cooler atmosphere; women and older people prefer warmer atmosphere. (3) Activity - Physical exertion requires a lower effective temperature. (Effective temperature is an arbitrary index of the degree of warmth or cold felt by the human body in response to the combined effects of temperature, humdity and air movement). (4) Season - The body is more comfortable when the effective temperature is: 63° to 71° F. in the winter and 66° to 75° F. in the summer. (5) Relative temperature of surrounding walls- cold walls increase radiation of heat from the body and raises the effective temperature for comfort. (6) Psychological - Fresh air "fiends" are uncomfortable with windows closed even when the conditions are known to be optimum.

Modern Standards of Ventilation are Based on Comfort

Comfort is determined by: (1) Skin temperature - this is the most important factor. The skin nerve endings are stimulated to produce a feeling of comfort. Comfort temperatures of the skin range between 30°C. and 35° C. or between 82°F. and 95°F. (2) Stuffiness - this is probably due to conditions of the mucous membrane of the nose. Uncomfort may be due to nasal membrane dryness or dilatation of the blood vessels in the mucous membrane caused by heat. (3) Fluctuation of temperature and air movement.

The dry-bulb temperature is the temperature registered by an ordinary thermometer. The wet-bulb temperature is the lowest temperature which a water wetted body will attain when exposed to an air current. The wet bulb temperature is usually lower than the dry bulb temperature, since evaporation of the water causes a cooling process.

The effective temperature, as above explained, is an arbitrary index of the degree of warmth or cold felt by the human body in response to the combined effects of temperature, humidity and air movement. The numerical value of the effective temperature for any given air condition is fixed by the temperature of moist-saturated air which at a velocity of 15 to 25 feet per minute, induces a sensation of warmth or cold like that of the given condition. Thus, any air condition has an effective temperature of 65° when it induces a sensation of warmth like that experienced in practically still air 65° and saturated with moisture.
The Kata-thermometer is used to determine the cooling characteristics of the air of a room. It is an alcohol thermometer.
The dry-bulb temperature of comfort is 68° to 75° for resting individuals; about 65° F. for those doing light work, and around 60° F. or less for those doing heavy work. These comfort temperatures are different in different countries or parts of countries due to the factor of acclimatization (which appears to depend on the nerves controlling the blood vessels and the fluidity and volume of the blood.
The primary factors in air conditioning are temperature, humidity, air-movement, and body odors.

Temperature

There are no experiments giving information relative to air conditioning and health, although there appears to be some relation between excessive differences of temperatures of inside and outside buildings and common colds.
Twenty degrees F. difference between the inside temperature and outside temperature is probably too great. Ten degrees F. is probably much better.
A person's mechanical efficiency (amount of work done related to amount of O_2 utilized) is not affected by high temperature, but the capacity (work done in a unit of time) is decreased by moderately high temperatures. One experiment indicated that the capacity decreased about 28% in changing the temperature from 60°F. to 80° F. during a working period. This even occurred if the humidity was at the same time decreased. Accidents will increase on the job if the temperature and the humidity are inordinately increased.
Heat is transmitted in three ways: (1) Conduction (2) Convection (3) Radiation.
When heat energy gradually diffuses through a mass of matter, passing from particle to particle from warmer toward the colder parts of a body, the process is called conduction. In this case, energy of motion is conceived as communicated from molecule to molecule progressively through out the mass.
When heat is carried along by the motion of a stream of gas or liquid, the process is called convection. This is the most common method of heating buildings in the United States. Hot air, hot water, and steam heaters cause warm air currents to circulate in the building, i.e., by convection.
In the above two cases the transference of heat takes place in and through matter, but a hot body surrounded by a perfect vacuum may give out energy and warm neighboring objects. In this case the enrgy is transmitted by waves in the ether and the process is called radiation. Heating by radiation is by open grates, unjacketed stoves, electric heaters, gas burners, etc.

A method of heating which has not yet been much exploited, is the maintenance of warm walls in the presence of cool air. This method gives greater comfort since the presence of cool air is refreshing, yet the radiation from the walls maintains an adequate feeling warmth of the body.

Air Temperature	Wall Temperature	--- Sensation as though air and walls are -
68°F.	68°F.	68°F.
60°F.	79°F.	68.4°F.
55°F.	89.3°F.	70.3°F.
50°F.	101.0°F.	72.7°F.
45°F.	114.3°F.	75.8°F.

This shows how much air can be cooled if the surroundings are heated.

Humidity
There is no evidence that humidity has any effect on health, although it definitely has an effect on comfort. It is possible that a low humidity may cause a drying of the nasal membranes with consequent predisposition to infection.
Relative humidity is the ratio between the amount of water vapor in the air at a particular temperature and the amount of water vapor that the air could hold at that temperature.
At 70°F. humidity plays little part in comfort, but when the temperature is high, increasing the humidity will decrease the ability of the body to lose heat, due to the decreased evaporation of perspiration from the skin. Therefore, at high temperatures it becomes important to maintain a low humidity. When the temperature is low, an increased humidity will cause one to feel colder, due to the moisture in the clothing causing an increased conduction of heat away from the body. Therefore it is important to maintain a decreased humidity in cold weather if comfort is to be served.

Air-Movement
Air-movement is important in heat loss from body, because it changes the air in contact with the skin. Air-movement always increases heat loss from the body with one exception when the temperature of the air is the same as that of the body and the relative humidity is 100 percent. Air-movement may have some effect on the pressure nerves in the skin, increasing muscle tone and producing a pleasant feeling.
Increasing air-movement is equivalent to lowering the temperature:
If the draft temperature is same as room temperature then 40-80 ft./min. is comfortable
If the draft temperature is 1°-1½°F. below room temperature then 25 ft./min. is pleasant
If the draft temperature is 1½ -2°F. below room temperature than 40 ft./min. is uncomfortable.
If the draft temperature is more than 2°F below room temperature then 50 ft./min. is very uncomfortable.
In this country, an air movement of 50-60 ft./minute is optimum if the draft temperature is the same as the room temperature.
The head is much more susceptible to the comfort of discomfort due to air movement than the feet or ankles. When the feet temperature of air is as much as 2°F lower than the head level temperature, a feeling of discomfort is usually produced.

Body Odor and Room Space
Body odors and room space have no apparent effect on physical health directly, but may effect physical health indirectly by their effect on mental health.
The following figures are arbitrary but do give an idea of adequacy of room space.

Floor space for 1st grade children	- 15 sq. ft. per pupil
Floor space for adult	- 25 sq. ft. per person
Air space for 1st grade children	- 200 cu. ft. per pupil
Air space for 2nd grade children	- 250 cu. ft. per pupil
Air space for 6th grade children	- 310 cu. ft. per pupil
Air space for adult	- 200 cu. ft. per person

Air supply used to be based on CO_2 standard as understood in 1895, and called for at least 30 cu. ft. of air per person per minute. This is considered today an illogical criterion on which to base a standard for air supply. The suffering from crowding is not due to lack of oxygen or excess of CO_2 but to excess of heat generated by the bodies of the people. The logical bases for air supply standard should be, then, heat regulation.

Relative figures for air supply are as follows:
For children
12 cu. ft./min/child where 470 cu. ft. of air space per child is allowed
21 cu. ft./min./child where 200 cu. ft. of air space per child is allowed
29 cu. ft./min./ child where 100 cu. ft. of air space per child is allowed
For adults
7 cu. ft./min./ person where 500 cu. ft. of air space per person is allowed
15 cu. ft./min./ person where 200 cu. ft. of air space per person is allowed
25 cu. ft./min./ person where 100 cu. ft. of air space per person is allowed

Air supply per square foot of floor space for - (1) School room - 2 cu. ft. per minute,(2) Gymnasium - 1.5 cu. ft. per minute, (3) Assembly Hall - 1.5 cu. ft. per minute.
Air supply should be changed in rooms at the rate of about 6 times per hour.
Ordinarily, 10 cubic feet of fresh outside air per minute per person will keep odors out.
Air should be properly distributed through out a room. This is determined by seeing that in no place in the room will the CO_2 content of the air be more than 10 parts in 10,000.

Ventilation in Schools
There is no difference in the health of school children whether they are subject to mechanical or non-mechanical methods of ventilation. The effect on the mental health, if any, has not been determined. There has been a general preference for window ventilation for schools so far as comfort is concerned.
Technique for window ventilation: (1) Radiator runs the entire length of window side of room. (2) Deflectors on window extend one foot in height to prevent draft. (3) Radiator shields are placed in front of radiators to prevent excess of heat on children near the radiators. (4) Gravity exhaust is located on opposite side of room near the ceiling to carry off warm air. (5) Windows should open easily at the bottom and shades guided by ropes and pulley should be used to avoid shaking of shades by the inflow of air. (6) Adequate air space in rooms should be provided in accordance to standards. (7) Large thermometer with 68° F. clearly marked should be displayed on teacher's desk.
Window ventilation requires a lower temperature (68°F) than fan ventilation (70°F) because fan ventilation produces greater air movement. Window ventilation at 68 °F produces less respiratory diseases than fan ventilation at 70°F.
In rural schools, jacket stoves are used for heating and distributing the air. This method works fairly well in an inadequate situation, but should be replaced by other methods more satisfactory when possible.
No one type of ventilation is universally satisfactory: (1) Window ventilation alone is satisfactory for living rooms, sleeping rooms, hospital rooms, etc. (2) Window inlets with gravity exhausts are satisfactory for school rooms, ordinary offices, many factory workrooms, etc. (3) Fan ventilation is satisfactory for large crowded offices or workrooms, rooms with special heat sources present, auditoriums, crowded rooms with little heat loss through the walls and ceilings, etc. This type is used where windows cannot be opened or spaces are very large. (4) Modern air conditioning techniques are being developed for use in almost all circumstances. Their application is as yet not altogether satisfactory, but much is to be hoped for in the future from these techniques.

Carbon Monoxide
The increased use of natural and artificial gas for heating purposes has developed a hazard which has frequently resulted in deaths. The deaths may be due to leakage of the fuel gas itself, but the greater danger is the carbon monoxide (CO) which may be generated by faulty appliances. The danger is increased by the fact that CO is odorless and non-irritating. When breathed in it first causes headache, weariness, dizziness, followed by nausea,vomiting and finally death. The symptoms are caused by the fact that the CO has a chemical affinity for the hemoglobin of the blood, thereby interfering with its normal oxygen-carbon dioxide-carrying power. CO is a common constituent of manufactured gas. It is produced by the incomplete combustion of any organic matter.

Water gas contains 38.0% CO	Illuminating gas contains 24.9%	Producer gas contains 20.0%
Exhaust gas contains 6.3%	Coal gas contains 6.0%	Natural gas contains 0.4%

Natural gas leakage would not cause CO poisoning, but incomplete combustion of it would cause such poisoning. Any place where gas of any kind is used for power, CO is produced. It is produced by pouring molten metal into molds, blasting, explosions, fires, compressors (where oil is used) etc. CO has an affinity for the hemoglobin, 300 times greater than O_2. A person can stand 1 part in 10,000 of CO in the air indefinitely. Four parts per 10,000 is safe for 1 hour. If the concentration in the blood rises above 20% saturation, dizziness and nausea sets in. Higher concentrations produce acute symptoms and if not removed from the blood, the person may die. Ventilation is becoming an important industrial hygiene problem due to the many gases and dusts produced in industry.

References: (1) Municipal and Rural Sanitation - Ehlers and Steel
(2) Rural Health Practice - Mustard
(3) Preventive Medicine and Hygiene - Rosenau
(4) Housing for Health - American Public Health Association

Making Concrete

(Abstracted from - A Practical Course in Concrete-Portland Cement Assoc.)

Definitions:
Concrete is a mixture in which a paste of Portland cement and water binds fine and coarse materials, known as aggregates, into a rock-like mass as the paste hardens through the chemical action of the cement and water. Concrete is, thus, composed of an active material (cement) and inert materials aggregated.
Portland cement was invented around 1824 by Joseph Aspdin. The present Portland cement is a finely pulverized material consisting principally of certain definite compounds of lime with silica, alumina, and iron oxide, which is capable of hardening into a solid mass through chemical combinations of the various compounds with water.
Mortar is a mixture similar to concrete in which no large size aggregate is used.
Fine aggregate or sand includes all particles from very fine (exclusive of dust) up to those which just pass through a screen having 4 meshes to the linear inch.
Coarse aggregate or gravel includes pebbles, crushed stone or crushed slag cinders, burned shale and other suitable materials ranging from 1/4 inch to 1-1/2 inches or more in size.
The four principle requirements in making concrete are: (1) Strength (2) Durability (3) Workability (4) Economy.
The first two are requirements of the finished product; the third is the principle requirement of the plastic product; and the fourth becomes very important as the amount of concrete tobe used increases.
Concrete of good quality can be produced by: (1) Using suitable materials (2) Correct proportioning of materials (3) Careful mixing of materials (4) Correct placing of concrete paste (5) Correct finishing of surface of concrete (6) Correct curing of concrete.
When the materials for concrete are first mixed together, the cement and water form a paste which surrounds the particles of the aggregate and holds them together in a plaster mass. A chemical action then takes place between the cement and water causing the paste to harden. One of the most important principles in making concrete is: The potential quality of the concrete paste is determined by the quantity of water mixed with the cement.
If too much water is added, the paste becomes thin and will be weak when it hardens, because the particles of the aggregate will not be held firmly together. On the other hand, cement paste which has good binding qualities will hold the particles firmly together, making strong concrete. Therefore, water and cement are the important ingredients in a concrete mixture.

Using Suitable Materials:
It is important to keep vegetable matter out of sand in order to get the best results in making concrete. The colorimetric test is a reliable indicator of the presence of such matters. The test is performed as follows: (1) Fill a 12 ounce bottle with sand up to the 4-1/2 mark. (2) Add 3% solution of sodium hydroxide (caustic soda) to the 7 ounce mark. (3) Shake thoroughly and allow to stand 24 hours.
Readings: (1) If liquid remains colorless, then no organic matter is present. (2) If liquid is straw colored, then some vegetable matter is present, but not enough to be objectionable. (3) If liquid is darker, then sand contains injurious amounts of vegetable matter and should not be used unless washed.
A simple method of washing sand is: build a wooden incline, place the material on the higher end of the incline. Water is supplied by a garden hose, pail, or other convenient means. As the materials are washed down the incline, silt, dust and organic matter separate out and are carried away by the water. Near the bottom of the incline is an opening covered with fine mesh screen (50 meshes to the linear inch) through which the fine particles pass with the water.
In general, water that is fit to drink is suitable for mixing with cement. The water should be clean and free from oil, alkali or acid.
Good quality cement depends first of all on the materials from which it is made and the process by which it is manufactured. The cement must be finely pulverized since only in this state does it react chemically with water. Cement that has been moistened and hardened into cake form is not to be used.

Correct Proportioning of Materials:
The direct relation between strength of concrete and the relative quantities of water and cement in the mixture is expressed by the water-cement ratio strength law: "For given materials and conditions of handling, the strength of concrete is determined primarily by the ratio of the volume of mixing water to the volume of cement so long as the mixture is plastic and workable."
In other words, if 7 gallons of water are used for each sack of cement in a mixture, the strength at a certain age is practically fixed, regardless of what quantities of aggregate

are used, so long as the mixture is plastic and workable and the aggregates are clean and made up of sound particles.
True plasticity means a mixture neither too wet nor too dry, and capable of being molded into a dense, compact mass. In over wet mixtures the fine aggregates, separate from the coarse aggregates. Too dry mixtures cannot be compacted properly. It should be stiff enough to stick together, yet not dry enough to be crumbly.
Workable concrete places and finishes readily. In other words, it has just enough cement paste to fill completely the spaces between the particle of aggregate, allowing no honey-combing, and to insure a plastic mix that finishes easily.
A mixture that is workable for one job, may be too stiff for another, that is, concrete to be placed in thin sections must be more plastic than if used in heavier work.
To obtain plastic mixtures more water is used than can be permanently combined with the cement even with the most extended curing. A certain amount of water, therefore, remains uncombined and distributed within the paste. The space it occupies will be presented by air voids as the water evaporates. Therefore where watertight concrete is needed, less water is used than where watertightness is not so important.
The table below showing the "recommended proportions of water to cement and suggested trial mixes" is based on the following facts:
(1) A cement paste made in a proportion of not more than 5 gallons of water to one sack of cement will produce satisfactory concrete for work subjected to severe wear, weather, or weak acid and alkali solutions.
(2) A 6 gallon paste produces concrete which is watertight and is satisfactory when subjected to moderate wear and weather.
(3) A 7 gallon paste will produce concrete which is suitable for use where it will not be subjected to wear, weather or water pressure.

RECOMMENDED PROPORTIONS OF WATER TO CEMENT AND SUGGESTED TRIAL MIXES

Kinds of work	Add U.S. gals of water to each sack batch if sand is			Suggested Mixture for trial batch			Material per cu.yd. of concrete		
	Very Wet	Wet	Damp	Cement Sacks	Aggregates Fine Cu.Ft.	Aggregates Coarse Cu.Ft.	Cement Sacks	Aggregates Fine Cu.Ft.	Aggregates Coarse Cu.Ft.
5 - Gallon paste for concrete subjected to severe wear, weather or weak acid and alkali solutions									
Colored or plain topping for heavy wearing surfaces as in industrial plants and all other two course work such as pavements, walks, tennis courts, residence floors, etc.	4¼	Average Sand 4½	4-3/4	1	1	1½	10	12	15
							Maximum size aggregate 3/8"		
One-course industrial, creamery and dairy plant floors & all other concrete in contact with weak acid or alkali solutions	3-3/4	4	4½	1	1-3/4	2	8	14	16
							Maximum size aggregate 3/4"		
6 - Gallon paste for concrete to be watertight or subjected to moderate wear and weather									
Watertight floors such as industrial plant, basement, dairy barn, etc. Watertight foundations Concrete subjected to moderate wear or frost action such as driveways, walks, tennis courts, etc. All watertight concrete for swimming & wading pools, septic tanks, storage tanks, etc. All base course work such as floors, walks, drives, etc. All reinforced concrete structural beams, columns, slabs, residence floors, etc.	4¼	Average Sand 5	5½	1	2¼	3	6½	14	19
							Maximum size aggregate 1½"		

7 - Gallon paste for concrete not subjected to wear, weather or water

Foundation walls, footings, mass concrete, etc., not subjected to weather, water pressure or other exposure.	4-3/4	Average Sand $5\frac{1}{2}$	$6\frac{1}{4}$	1	2-3/4	4	5	14	20
					Maximum size aggregate $1\frac{1}{2}$"				

Quantities are estimated on wet aggregates using suggested trial mixes and medium consistencies - quantities will vary according to the grading of aggregate and the workability desired. It may be necessary to use a richer paste than is shown in the table because the concrete may be subjected to more severe conditions than are usual for a structure of that type. For example, a swimming pool ordinarily is made with a 6-gallon paste. However, the pool may be built in a place where soil water is strongly alkaline in which case a 5-gallon paste is required.

This table shows how much allowance should be made for sand that is damp, wet or very wet.

Dry sand flows freely.

Damp sand feels damp to the touch but leaves little moisture on the hands. This sand usually contains about 1/4 gallon of water per cubic foot.

Wet sand feels wet and leaves a little moisture on the hands. It contains about 1/2 gallon of water per cubic foot.

Very wet sand is dripping wet when delivered on the job and leaves more moisture on the hands than wet sand. It carries about 3/4 gallon of water per cubic foot or a little more.

Correcting Trial Mixtures:

If the trial mixture is not workable, it is necessary to change the amounts of aggregates used in the concrete. Under no circumstances should the total amount of water specified for the particular class of work be changed.

If the trial mixture is too wet, add small amounts of sand and coarse aggregate in the specified proportion until the right workability is obtained.

If the concrete is too stiff and appears crumbly, succeeding batches are mixed with less aggregate. Usually slightly less coarse material will give the required workability.

Proportioning for Economy:

Adherence to the water-cement ratio method will control quality, but may not result in economical concrete.

To secure a dense, impervious concrete, it is essential that all surfaces of the particles of aggregate be thoroughly coated with cement paste and all voids filled. It can be readily seen that to secure economical concrete using as little cement as possible (since cement is the expensive element in concrete), it is necessary to select an aggregate with a low surface area and as few voids or air spaces as practical.

It must be remembered that in a given volume of aggregate, the larger the particles, the smaller will be the total surface to cover. Also that the more spherical the particles the more the voids, the more cubical the particles the less the voids. But since a good deal of the aggregate particles are spherical more or less, the use of aggregate made up of large particles will give a smaller surface for the paste to cover but it will leave many voids. To reduce the voids as much as possible, aggregates composed of smaller particles should be intermixed. Therefore, an economical aggregate is one which is composed of particles ranging in size from the largest allowable for the job at hand down to finer sizes. Such an aggregate will have the desirable combination of low percentage of voids and low surface area. However, the amount of coarse aggregate which can be used is often limited by the amount of exposed surface of the concrete rather than by the economy of mixture. The larger the exposed surface and the thinner the layer of concrete the more it becomes necessary to limit the amount and size of coarse aggregate.

In order to preserve quality and increase the quantity of concrete made from each sack of cement, it is desirable to increase the aggregate in correct proportions. Experience has shown that for average jobs, the proportion of aggregate should be about 40% sand and 60% coarse aggregate. Generally, a slightly over sanded mix is the most desirable. The following recommendations will prove helpful:

For coarse aggregate ranging from 1/4 inch up to $1\frac{1}{2}$ inches, use approximately 40% sand and 60% coarse aggregate.

For coarse aggregate ranging from 1/4 inch to 3/4 inch, use about 50% sand and 50% coarse aggregate.

Another factor which must not be forgotten is that moisture in sand forms films of water over the surfaces of the particles, fluffing them apart. This causes an increase in the volume, when measured in the loose condition, much greater than the volume of water in the sand, so that a given volume of damp sand may be the equivalent of a much smaller volume of dry sand.

The following table may be helpful in estimating materials.

Quantities of Cement, Fine Aggregate and Coarse Aggregate Required for 1 cub. yard of Compact Mortar or Concrete.

Mixtures			Quantities of Materials		
Cement	F.A. (Sand)	C.A. (Gravel or stone)	Cement in sacks	F.A. Cu. Ft.	C.A. Cu. Ft.
1	2	. . .	12	24	. . .
1	3	. . .	9	27	. . .
1	1	1 -3/4	10	10	17
1	1-3/4	2	8	14	16
1	2-1/4	3	6-1/4	14	19
1	2-3/4	4	5	14	20

1 sack cement = 1 cu. ft.

All materials including water should be accurately measured. Aggregates can easily be measured by using a bottomless box made to hold exactly 1 cubic foot or any other volume. The box is placed on the mixing platform and filled. When the box is lifted the contents remain on the platform. Measuring may also be done by pails, shovels, wheelbarrows or by weight. The important factor is to be accurate.

Careful Mixing of Materials:

Whichever way mixing is done, it should continue until every pebble or stone is completely coated with a thoroughly mixed mortar of sand and cement.

Machine mixing is displacing hand mixing.

The usual procedure in mixing concrete by hand is as follows:.

The measured quantity of sand is spread out evenly on the platform. On this the required amount of cement is dumped and evenly distributed. The cement and sand are then turned over thoroughly with No. 2 square pointed shovels enough times to produce a mass of uniform color, free from streaks of brown and gray. Such streaks, when present, indicate that the sand and cement have not been thoroughly mixed.

This mixture is spread out evenly over the platform and the required quantity of pebbles or broken stone is then measured and spread in a layer on top. The materials are again mixed by turning with shovels until the pebbles have been uniformly distributed throughout the mixture of cement and sand. At least three turnings are necessary.

A depression or hollow is then formed in the center of the pile and the proper amount of water added slowly while the materials are turned in toward the center with square pointed shovels, this turning being continued until the cement, sand and pebbles have been thoroughly and uniformly combined and the desired workability and smoothness obtained.

Correct Placing of Concrete Paste:

Moving concrete a considerable distance after mixing and before placing is never desirable because segregation of the coarse from the fine particles may occur. A rather stiff consistency usually is required to prevent segregation.

Concrete should be placed in the forms as soon as possible and in no case more than 45 minutes after mixing. All debris should be removed from forms and they should be thoroughly wetted or oiled before placing of concrete.

Concrete should be deposited in level layers, not more than 12 inches deep, and tamped and spaded just enough to make it settle thoroughly and produce a dense mass, snugly fitting into every space of the form.

At the end of a day's work or where the work has to stop long enough for the concrete to begin hardening, roughen the top surface just before it hardens to provide a good bond for the next layer of concrete. Just before resuming concreting, the roughened surface should be cleaned and brushed with a cement-water paste of a thick, creamy consistency. The paste should be applied in a thick brush coat just a few feet ahead of the concreting operation so that it does not have a chance to dry before it is covered with concrete.

Correct Finishing of Surface of Concrete:

Concrete is leveled carefully just after it is placed in the forms. This removes all humps and hollows leaving a true, even surface for the final troweling operation.

Smooth finishes are produced with a steel trowel, care being taken to prevent too early troweling or excessive troweling, which are likely to result in surfaces that will dust or develop numerous fine cracks called hair checks.

The time of final finishing is important. If the concrete is allowed to stand until it is quite stiff but still workable, the steel trowel will compact the concrete and produce a dense surface without drawing the cement and fine material to the surface.

A wood float is useful in making an even yet gritty, non-slippery surface for side-walks, driveways, and floors. Final finishing is delayed until the surface has become quite stiff. A final finish on driveways, pavements, and similar work can be produced with a belt of wood, canvas or rubber, not less than 6 or more than 12 inches wide and at least 2 feet longer than the width of the slab being finished. This is laid on the surface of the concrete immediately after the wood float has been used. For the first application,

vigorous strokes crosswise of the slab and at 12 inches long are used, advancing slowly forward along the slab as the surface is made smooth and even. The second application of the belt is made immediately after the water sheen disappears, with the stroke of the belt being not more than 4 inches and the movement along the slab slightly greater than for the first belting.

Surface water should be avoided. However, when there is a small amount present, it should be allowed to evaporate before finishing. If there is considerable water, it should be removed with a broom, belt, float or other convenient means. It is never good practice to sprinkle dry cement or a mixture of cement and fine aggregate on concrete to take up surface water, since such fine materials form a layer on the surface that is likely to dust or hair check when the concrete hardens.

Correct Curing of Concrete:

The chemical action between the water and cement continues so long as temperatures are favorable and moisture is present to hydrate the cement. Watertightness, durability, and strength of concrete increase with age due to the continued chemical action.

Moist curing greatly increases the strength and watertightness of concrete. Heat increases the rate of hardening.

Wet burlap, canvas, sand or straw coverings are often used to protect newly placed concrete. The covering is placed as soon as it can be done without marring the surface. Care should be taken to keep the covering continuously wet by sprinkling. When a cover is not used, wetting of the concrete should be begun **immediately** after finishing and the surface should not be permitted to dry during the curing period.

Ponding is a good method of curing for flat surfaces. With this method, the surface to be cured is surrounded by small earth dikes and then kept flooded with water for several days.

Walls and other vertical surfaces can be protected by leaving the forms in place temporarily, or by hanging canvas or burlap over them. Such coverings are kept constantly moist by sprinkling. Curing should continue for at least 7 days, and for longer periods when it is practical against freezing.

In cold weather, concrete must be protected against freezing. In early winter, when freezing temperatures occur only at night, it is necessary merely to protect concrete from freezing after it is placed. As the weather grows colder and freezing temperatures prevail, the mixing water and aggregates are heated and the work protected.

Equipment:

Most of the tools required in concrete work are simple and many of them can be home-made. The principle ones are the following:

1. Screen	7. Hose	13. Edger
2. Mixing platform	8. Tamper	14. Groover
3. Square pointed shovels	9. Spading tool	15. Wheelbarrow
4. Measuring box	10. Strike board	16. Small wire brushes
5. Water barrel	11. Wood float	17. Straight edge
6. Pails	12. Steel trowel	18. Measures (gallon & quart)

A sand screen should be 2 ft. 6 in. or 3 ft. wide, and 6 ft. long. The frame may be made of 1½ or 2 in. lumber, 4 to 6 in. wide. Legs should be so attached to the sides that the screen can be set at the desired angle while throwing material upon it to separate the sand from the pebbles. This angle should be about 45 degrees. A piece of wire cloth or fabric having 4 meshes to the linear inch should be nailed to the frame. Material to be screened is thrown with a shovel against the upper portion of the screen and, in rolling down, the coarse aggregate is separated from the fine aggregate.

For hand mixing, a watertight mixing platform at least 7 ft. wide by 12 ft. long should be provided. A platform of this size is large enough to permit two men using shovels to work upon it at one time.

It may be made by using a piece of sheet steel about 1/8 in. thick with 2 by 4's set on edge and properly fastened to three of the form edges or sides of the steel; or the platform can be made entirely of wood. In this case the floor of the platform should be of not less than 1½ in. lumber, 4 to 6 in. wide, tongued and grooved, and surfaced. If tongued and grooved lumber is not obtainable, the edges of the boards should be planed or jointed so that they can be nailed closely together on three 4 by 4-inch stringers, placed 2 ft. or more apart, to make a firm, unyielding platform. Two by four strips should be nailed to three sides so that materials will not be shoveled off the board in mixing.

The measuring box is necessary to measure exact quantities of sand and pebbles or broken stone. Such a box is a bottomless frame made of 1 or 1½ inch material and should have a capacity of not less than 1 cu. ft. If larger, it should be of 2 or 3 cu. ft. capacity and should be marked on the inside to show levels at which volume will equal 1 cu. ft., 2 cu. ft. etc. Handles are placed on the side of the box to make lifting easy after the material required has been measured.

DIMENSIONS FOR BOTTOMLESS MEASURING BOXES

Capacity in Cu.Ft.	Inside Measurements in Inches		
	Length	Width	Height
1	12	12	12
1 $\frac{1}{2}$	15	15	$11\frac{1}{2}$
2	18	18	10-5/8

Ordinary square pointed shovels are used for mixing concrete.

For transferring concrete from the mixer or mixing platform to the place of final use, a wheelbarrow may be needed. One with a sheet iron body should be used having the front of the body higher than the back to prevent loss of concrete when the barrow handles are raised in position for wheeling.

When placing concrete in forms, it must be spaded and tamped. A tamper may be made by boring a $1\frac{1}{2}$ inch hole in the end of an 8 x 8x12 inch piece of timber and inserting a handle about 4 feet long. A metal tamper may also be used, or one can be made of concrete.

A spading tool of some kind is necessary to settle the material in the forms properly and also to secure a surface finish free from pebble pockets. Such a spading tool may be made by flattening an ordinary garden spade or by straightening out an old garden hoe, Such tools are used by working them up and down in the concrete close to the form faces so as to force back coarse particles and bring sand-cement mortar to the form face.

Sometimes a chisel-edged board 4 to 6 inches wide may be used for spading concrete, the upper end being shaped to form a convenient handle. When reinforcing metal is placed in the concrete, smaller spading tools will be needed to work in the smaller spaces. Thin sticks, steel rods, or narrow chisel-edged pieces of wood are used for this purpose.

A strikeboard is merely a piece of $1\frac{1}{4}$ or 2 inch lumber, 4 inches or more wide, and long enough to rest across the top of the form, as in sidewalk construction, so that the top of the concrete can be approximately leveled before final finish.

A wood float is used to finish the surface of the concrete after it is struck off, as in building walks, pavements and floors. This is a simple tool and can be made by anyone.

A steel hand float or trowel may sometimes be required where a smoother surface is desired than can be obtained with the wood float.

For finishing joints between slabs in walks, floors, and similar concrete work, a tool known as a groover is used, while for finishing the edges of the slabs the tool used is known as the edger.

A water barrel and pails are necessary for adding the required amount of water to the correctly measured materials.

Most of the batch mixers in use have revolving drums with fixed blades inside, though a few have fixed drums with revolving blades or paddles. The latter type is commonly used in block manufacture where very dry mixes are employed. The drums may be shaped like cylinders, double cones or cubes. Several manufacturers of concrete mixers make machines that are relatively cheap and at the same time very efficient.

The speed of the drum is important. If it rotates too fast, the materials will tend to be held next to the rim, while if the speed is too slow, thorough mixing will not be accomplished in the usual time. A peripheral speed of about 200 ft. per minute is satisfactory.

Problems:

1. How many sacks of cement will be required for a driveway using $8\frac{1}{2}$ yd. of concrete? How many cu. ft. of sand will be required? How many cu. ft. of pebbles will be required? How many gallons of water?
   Answer - Mix $1:2\frac{1}{4}:3$ If sand is dry use 6 gal. water per sack cement.
   Material Required:
   1 cu. yd. requires:
   6.25 sacks cement — 53 sacks cement
   14.0 cu. ft. sand x 8.5 cu. yd = 119 cu. ft. sand
   19.0 cu. ft. pebbles — 161.5 cu. ft. pebbles
   6.25 x 6 = 37.5 gal.water — 318.75 gal. water
2. What will be the total volume in cu. yd. of concrete mixed in 23 one-sack batches, concrete to be used for heavy foundation work?
   Answer - Mix 1:2-3/4:4 If sand is dry use 7 gal. water per sack cement.
   Materials required:
   1 cu. yd. requires:
   5.0 sacks cement — Therefore 23 one-sack batches at 5
   14.0 cu. ft. sand — sacks cement per cu. yd. produces:
   20.0 cu.ft. pebbles $\frac{23}{5}$ 4.6 cu. yd. concrete
3. Find the volume of concrete required in a foundation of a rectangular building 31 ft. by 62 ft. outside dimensions, wall to extend from frost line to 12 in. above grade. Frost line is considered 3 ft. below grade. Wall averages 10 in. in thickness. Wall area of 18 sq. ft. to be deducted for openings.
   Answer - Volume of wall is 31 x 2 = 62 lin.ft. plus 62 x 2 = 124 lin. ft. or 186 lin. ft. Average height is 4 ft. (one cu. yd = 27 cu. ft.)

31 x 2 = 62
62 x 2 = 124
186 lin. ft. x 4 = 744 sq.ft.

744 sq. ft.
− 18 sq. ft. (openings)
726 sq. ft. net area

$\frac{726}{1} \times \frac{10}{12} = 605.0$ cu. ft. $\frac{605}{27} = 22.4$ cu. yd.

4. Find the approximate amounts of sand, cement, pebbles and water required for the foundation mentioned in problem No. 3
Answer - Mix 1:2-3/4:4 If sand is dry use 7 gal. water per sack cement.
Material Required:
1 cu. yd. requires:

1 cu. yd.		Total
5.0 sacks cement	x 22.4 cu. yd. =	112 sacks cement
14.0 cu. ft. sand		313.6 cu. ft. sand
20.0 cu.ft.pebbles		448 cu. ft. pebbles
7x5 = 35 gal. water		784 gal. water

5. How many square feet of sidewalk can be made per sack of cement, making the slabs 5 inches thick?
Answer - Mix 1:2¼:3 If sand is dry use 6 gal. water per sack cement.
Materials Required: (27 cu. ft. equals 1 cu. yd.)
1 cu. yd. concrete:
6.25 sacks cement)
14.0 cu. ft. sand) $\frac{27}{6.25}$ = 4.32 cu. ft. per sack
19.0 cu. ft. pebbles)

$4.32 \times \frac{12}{5} = \frac{51.84}{5} = 10.37$ sq. ft. per sack cement.

6. How many loads of cement will be required for the foundation mentioned in problem No. 3 if the wagons or trucks in which hauling is done can carry two tons over the roads which must be traversed in making this delivery?
Answer - Mix 1:2-3/4:4
5.0 sack cement required per cu. yd. concrete (sack weighs 94 lb.)
5 x 22.4 cu. yd. = 112.0 sacks cement
$\frac{112 \times 94 \text{ lb.}}{4000 \text{ lb.}} = 2.632$ loads of 2 tons each.

7. A tank wagon holds 20 barrels of water. Each barrel holds 31½ gal. How many loads will be required to furnish mixing water for 108 cu. yd. of concrete if 5 gal. of water are required per sack of cement?
Answer - Mix 1:1:1½ or 1:1-3/4:2
Materials Required: 31.5 gal. x. 20 bbl. = 630 gal. per load.
1 cu. yd. concrete
10.0 sacks cement (1:1:1½ mix) x 5 gal. = 50.0 gal. water
8.0 sacks cement (1:1-3/4:2 mix) x 5 gal. = 40.0 gal. water

$\frac{50 \times 108}{630} = 8.57$ loads or $\frac{40 \times 108}{630} = 6.86$ loads.

8. A circular water tank provided to supply steam traction engines is 18 ft. inside diameter and 20 ft. in height from footing to top of wall; maximum water depth is 15 ft. How much water will it hold in gallons and barrels?
Answer - Assume: 1 bbl. holds 31.5 gal. water. (7.5 gal. equals 1 cu.ft.)
Volume of tank (liquid capacity) is $\pi r^2 h$
$3.1416 \times 9^2 \times 15$ ft. = $3.1416 \times 81 \times 15 = 3817$ cu. ft.
$3817 \times 7.5 = 28{,}627$ gal. $\frac{28{,}627}{31.5} = 908.0$ bbl.

9. In the above tank the first 3 ft. of wall is 8 inches thick, the remainder 6 inches. If the floor is 8 inches thick, placed 4 feet above bottom of footing, how much cement, sand, pebbles and water will be used to construct the job?
Answer - Mix 1:2¼:3 If sand is dry, use 6 gal. water per sack cement.
Materials Required: (18.67 ft. diameter at center of 8 in. wall)
(18.5 ft. diameter at center of 6 in. wall)
1 cu. yd. concrete

1 cu. yd. concrete		Total
6.25 sacks cement	x 29 cu. yd. =	181.25 sacks cement
14.0 cu. ft. sand		406.0 cu.ft. sand
19.0 cu.ft. pebbles		551.0 cu. ft. pebbles
6.25 x 6 = 37.5 gal.water		1087.5 gal. water

Detail of problem: d - circumference of circle at center of wall section.
π = 3.1416 x 18.67 58.65 lin. ft. (8 in. wall)
117.3 cu. ft. -- Volume of 8 in. wall = $58.65 \times \frac{8}{12} \times 3 = 117.3$ cu.ft.
π d = 3.1416 x 18.5 = 58.12 lin. ft. (6 in.wall)

494.02 cu. ft. -- Volume of 6 in. wall $= 58.12 \times \frac{6}{12} \times 17 =$ 494.02 cu. ft.

$\pi r^2 h$ = Volume of bottom slab (9 ft. radius)

169.65 cu. ft. -- Volume of 8 in. floor $= 3.1416 \times 81 \times \frac{8}{12} =$ 169.65 cu. ft.

780.97 cu. ft. total volume of concrete. $\frac{780.97}{27} =$ 29 cu. yd. concrete, (approximately)

10. How many cu. ft. of 1-3 cement-sand mortar in 100 concrete sewer pipes; inside diameter 38 in., length 4 ft. thickness of wall 5 inch? What is the weight per pipe?
Answer - $2\pi r$ = circumference of circle at center of wall section
43 in. = diameter of circle at center of wall section

2700 lb. = assumed weight of sand per cu. yd.
94 lb. = weight 1 sack (cu.ft.) portland cement

Materials Required: Mix 1:3
1 cu. yd. mortar
9.0 sack cement x 94 lb. = 846 lb.
27.0 cu.ft. sand x 100 lb. = 2700 lb.
Total 3546 lb. wt. mortar per cu. yd.

100 x 2 x 3.1416 x $\frac{43}{}$ x 5 x 48 = 1876 cu. ft. mortar in 100 pipe

$\frac{1876}{100} = 18.76$ cu. ft.? mortar per pipe $\frac{18.76}{27} = .695$ cu. yd. per pipe

.695 x 3546 = 2464.47 lb.weight per pipe

11. Compute cement, sand and pebbles required to build one mile of concrete road, width 20 ft., average thickness of slab 7 inches.
Answer - Mix 1:$2\frac{1}{4}$:3 If sand is dry, use 6 gal. water per sack cement
Materials Required:
1 cu. yd. concrete

6.25 sacks cement)		(14,256 sacks cement
14.00 cu.ft. sand)	x 228 cu. yd. =	(31,934 cu. ft. sand
19.00 cu. ft. pebbles)		(43,339 cu. ft. pebbles

$\frac{5280 \text{ ft.} \times 20 \times \frac{7}{12}}{27} = \frac{61{,}600 \text{ cu. ft.}}{27} =$ 2,281 cu. yd. concrete

12. What quantity of cement, sand, pebbles and water will be required to construct 100 fence posts 5 by 4 in. at the base, tapering on two sides to 3 x 4 inc. at the top, made 7 ft. long?
Answer - Mix 1:$2\frac{1}{4}$:3 If sand is dry, use 6 gal. water per sack cement
Materials Required:
1 cu. yd. concrete

6.25 sack cement)		(18.00 sacks cement
14.00 cu.ft. sand)	x 2.88 cu. yd. =	(40.32 cu. ft. sand
19.00 cu.ft. pebbles)		(54.72 cu.ft. pebbles
6.25 x 6 = 37.5 gal. water)		(108.00 gal. water

Average area in cross section is 4 in. x 4 in. = 16 sq. in.
16 sq. in. x 84 in. = 1,344 cu. in. or .777 cu. ft. per post
.777 x 100 = 77.7 cu. ft. per 100 posts, or $\frac{77.7}{27} =$ 2.88 cu.yd.

13. A concrete products plant has gang fence post molds sufficient to make 200 posts of size given in problem 12. How many charges of a two-sack batch mixer will be required to fill the molds?
Answer - 2.88 cu. yd. concrete required to make 100 posts in problem 12.
2 x 2.88 = 5.76 cu. yd. concrete for 200 posts
Since 6.25 sacks cement (or 1 sack batches) required per cu. yd. (problem 12)
Then 3.12 two sack batches are required per cu. yd. of concrete
3.12 x 5.76 = 18 charges of a two sack batch mixer required.

14. Find cost of materials required to build a retaining wall 20 ft. long, 4 ft. high and 2 ft. thick at base and 1 ft. thick at top. Use quotations from your market.
Answer - Mix 1: 2-3/4:4 Assume (Cement priced at $0.75 sack
(Sand priced at .07 cu. ft.
(Pebbles priced at .10 cu.ft.

Materials Required:
1 cu. yd. concrete

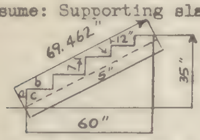
5.0 sacks cement)		22.20 sack cement at 0.75 sack =	$16.65
14.0 cu. ft. sand)	x 4.44 cu.yd. =	62.16 cu. ft. sand at 0.07 cu. ft. =	4.35
20.0 cu. ft. pebbles)		88.80 cu. ft. pebbles at $ 0.10 cu. ft. =	8.88
		Material Cost (assumed)	$29.88

15. Assuming that $\frac{1}{4}$ inch reinforcing rods weigh 0.167 lb. per foot, what will be the total weight of rods required to reinforce 100 posts as described in problem No. 12, using four rods to the post?
Answer - 100 posts x 4 rods x 7 ft. x .167 lb. per ft. = 467.6 lb. $\frac{1}{4}$ in. rods required.

16. Compute the amount of cement, sand, pebbles and water required to construct a set of steps if each step has 7 inch riser, 12 inch tread and is 4 feet long. Assume distance from edge of front step to house wall is 5 feet.
Answer - Mix (as for beams) 1:2$\frac{1}{4}$:3. If sand is dry, use 6 gal. water per sack cement
Materials Required:

1 cu. yd. concrete		Required
6.25 sacks cement	x .57 cu.yd.	3.56 sacks cement
14.00 cu. ft. sand		7.98 cu. ft. sand
19.00 cu. ft. pebbles		10.83 cu. ft. pebbles
6 x 6.25 = 37.5 gal. water		21.37 gal. water

Assume: Supporting slab 5 in. thick. Volume in treads only - Area of triangle



$\frac{HB}{2} = \frac{12 \times 7}{2} = 42$ sq. in.

42 x 48 in. = 2016 cu. in.

$\frac{2016}{1728} = 1.166$ cu. ft. per tread

5 treads x 1.166 = 5.83 cu. ft. in treads

Volume in supporting slab:
To find diagonal (length of supporting slab):

$\sqrt{60^2 + 35^2}$ = 69.462 inches length of supporting slab.
69.462 x 5 in thickness = 347.31 sq. in.

$\frac{347.31}{144} = 2.41$ sq. ft.

2.41 x 4 ft. width of stair = 9.64 cu. ft. concrete in slab

9.64 + 5.83 = 15.47 cu. ft. concrete in stair

$\frac{15.47}{27} = .57$ cu. yd. concrete required

17. How many sacks of cement will be required to construct a concrete feeding floor 18 ft. square and 4 in. thick? How many gal. of water will be required?
Answer - Mix 1:2$\frac{1}{4}$:3 If sand is dry, use 6 gal. water per sack cement

$\frac{18 \times 18 \times \frac{4}{12}}{27} = \frac{108 \text{ cu. ft.}}{27}$ = 4 cu. yd. concrete required

Material Required:
1 cu. yd. concrete
6.25 sacks cement) x 4 cu. yd. = 25 sacks cement required
14.00 cu. ft. sand)
19.00 cu. ft. pebbles)
6 x 6.25 = 37.5 gal. water x 4 cu. yd. = 150 gal. water required)

Elementary Vital Statistics

BIRTH, DEATH AND MORBIDITY RATES

Sanitarians should clearly understand the methods adopted and the terms used in compiling and recording information in numerical form regarding matters of population and public health. It is necessary to know the incidence of infectious and non-infectious diseases, birth and death rates, and infant mortality rates, in order to understand more clearly what forces are operating among our people or in particular communities that have direct and indirect bearing on public health activity. Such information gives leads as to what types of programs to carry on, how to carry them on, and where to place emphasis in one's work.

Population: The census of the United States is taken every tenth year, and has been taken ever since 1790. In order to unify the statistics of births and deaths in the United States, the federal government created the "U.S. Registration Area" in 1880, to which those states are admitted whose collections of birth and death data are adequate, i.e., where such statistics are collected for at least 90% of the population. In 1880, only two states, namely, Massachusetts and New Jersey were admitted. At present all states are in the "Registration Area". Louisiana was admitted to the registration for collection of deaths in 1918, for collection of births in 1927.

Rate: A rate, in vital statistics, is defined as a relation indicating the number of times a certain event may occur when a certain number of exposures to the risk of occurrence is present over a definite length of time. For example: The Death Rate in a population is the relation of the number of deaths which occur in a day, month, year, etc., in a definite population. This is expressed by the following equation:

$$\text{Death Rate} = \frac{\text{Number of deaths in one year}}{\text{Number in population during one year}}$$

Death Rates are usually expressed of "per 1000" or "per 100,000 population". Thus, the equation would be written:

$$\text{Death Rate} = \frac{\text{Deaths per year}}{\text{Population during that year}} \times \frac{1{,}000 \text{ or } 100{,}000}{} = \text{Number of deaths, per 1,000 or per 100,000 population for the particular year.}$$

The above is also called the Crude Death Rate, to distinguish it from the specific death rate, which deals with deaths from a certain disease or in a certain age-group.

Birth Rate is expressed as:

$$\frac{\text{Number of births in one year} \times 1000 \text{ or } 10{,}000}{\text{Population}}$$

Infant Mortality Rate is expressed as:

$$\frac{\text{Number of deaths in children under 1 year of age} \times 1000}{\text{Total live births}}$$

Case Fatality Rate is expressed as:

$$\frac{\text{Number of deaths amongst recognized cases of a certain disease} \times 100 \text{ or } 1000}{\text{Number of recognized cases of that certain disease}}$$

Population in intracensal years:

Because the census is taken only once every 10 years, it becomes necessary to determine population for the intervening years by mathematical approximation. This is done in the following manner: If the population of a certain community was

5,000 in 1930
7,000 in 1940

then the increase was 2000 over a 10 year period. Assuming that the growth of population is even and gradual, the growth each year was by addition of 200 people. Therefore, the population in 1935 was approximately 5000 + 5(200) or 6000; and the population in 1945 will be 7000 + 5 (200) or 8000.

Method of Working Common Problems for Sanitarian

1. Determine the amount of chloride of lime containing 25% available chlorine that would have to be added to a filled reservoir 15 ft. high and 30 ft. in diameter to provide 2 p.p.m. chlorine residual, if the water is estimated to have a 10 p.p.m. chlorine demand.

   1) 30 x 30 = 900 sq. ft.
   2) 900 x .7854 = 706.86 sq. ft.
   3) 706.86 x 15 = 10,602.9 cu. ft.
   4) 10,602.9 x 62.4 = 661,621 lbs. of water
   5) 2 p.p.m. + 10 p.p.m. = 12 p.p.m. of chlorine actually needed
   6) 661,621 : x : : 1,000,000 : 12
      1,000,000 x = 7,939,452
      x = 7.94 lbs. of chlorine

But the chloride of lime has only 25% available chlorine, therefore,

   7) $\frac{7.94}{25} \times 100 = \frac{794}{25} = 31.76$ lbs. of chloride of lime is needed.

2. Determine the retention period in a settling basin 15' x 40' x 10' if the flow through the basin is 240 gallons per minute.

   1) 15 x 40 x 10 = 6,000 cubic ft.
   2) 6,000 x 7.48 = 44,880 gals.
   3) 44,880 ÷ 240 = 187 minutes
      or 3 hours and 7 minutes retention period.

3. How much 4% stock solution of bichloride of mercury should be added to 20 gallons of water to make up a .3% solution?

   If: the stock solution is 4% and desired solution .3%,
   Then: The desired solution is .3/4 or $\frac{1}{13.3}$ times weaker than stock solution,
   Therefore: for each gallon of stock solution, 13.3 gallons of water must be added to make up a .3% solution
   If: 13.3 gallons of water added to 1 gallon stock solution will produce a .3% solution
   Then: 20 gallons of water must be added to x gallons of stock solution to produce a .3% solution
   Thus: 13.3 is to 1 as 20 is to x
   Or: 13.3 : 1 : : 20: x
   13.3 x = 20
   x = $\frac{20}{13.3}$ or 1½ gallons stock solution
   Therefore: 1½ gallons 4% stock solution must be added to 20 gallons of water to make up a .3% solution.
   Now, altering the problem slightly: How much 4% stock solution and water must be combined to make 20 gallons of .3% solution?
   If: 13.3 gallons of water added to 1 gallon 4% stock solution produces a .3% solution, the resulting quantity is equal to 13.3 gallons + 1 gallon or 14.3 gallons.
   Now if: In 14.3 gallons of .3% solution there is 1 gallon of 4% stock solution
   Then: In 20 gallons of .3% solution there is x gallons of 4% stock solution
   Thus: 14.3 is to 1 as 20 is to x or: 14.3 : 1 : : 20 : x
   14.3 x = 20
   x = $\frac{20}{14.3}$ or 1.4 gallons of stock solution
   Therefore: 1.4 gallons of stock 4% solution plus 18.6 gallons of water must be combined to make up 20 gallons of .3% solution.

4. A dug well 4 ft. in diameter is to be rebuilt. How much cement, sand, and gravel should be provided using a 1-2-3 mix?

   Well wall: The present well is 4' in diameter. Leaving the present well wall as an inside form the inside diameter of the concrete lining is 4'; the outside diamter is 4½ ft. Area inside circle $\frac{\pi D^2}{4} = \frac{3.1416 \times 16}{4} = 12.56$ square ft.

   Area outside circle $\frac{\pi D^2}{4} = \frac{3.1416 \times 20.25}{4} = 15.89$ square ft.

   Difference = 15.89 − 12.56 = 3.33 square ft.

$3.33 \times 10'$ (depth) = 33.3 cu. ft.
Platform 6' square and 4" thick
$6 \times 6 \times 1/3 =$ 12 cu. ft. Total 45.3 cu. ft. of concrete
45.3 cu. ft. concrete will need
$45.3 \times 3/2 =$ 67.8 cu. ft. of dry mix
Since the dry mix has about 1/3 of the volume in voids.
Using a 1 : 2 : 3 mix totaling 6 cu. ft.
$\frac{67.8}{6} =$ 11.3 cu. ft.

Therefore: Cement = $1 \times 11.3 = 11.3$ cu. ft. or sacks
Sand = $2 \times 11.3 = 22.6$ cu. ft.
Gravel = $3 \times 11.3 = 33.9$ cu. ft.

5. It is desired to find out the quantity of water flow in a small stream. A section of the stream should be selected that is reasonably straight with a bottom contour that is as uniform as possible. The cross-section of the stream can be figured by taking measurement of depth of water at various points across the stream. The average depth and width of the stream is estimated and the cross-section determined in square feet. The velocity of flow is measured by observing the speed of travel of a chip floating down the middle of the stream. The velocity should be measured in feet per second. The surface velocity is more rapid than the average velocity and it has been determined that 4/5 the surface velocity is equal to the average velocity.

   Therefore, the stream flow in cubic feet per second is equal to the cross-sectional area in square feet times the surface velocity in feet per second times 4/5.

   Example: Stream with average depth of 9 inches and approximate width of 5 feet. Surface velocity is 3 feet per second.
   Cross-sectional area $= \frac{9}{12} \times 5 = \frac{45}{12} = \frac{15}{4} = 3.75$ sq. ft.
   $3.75 \times 3 \times \frac{4}{5} = 11.25 \times \frac{4}{5} =$ 9 cu. ft./sec.
   9 cu. ft./sec. $\times 7.5 = 67.5$ gallons per sec.
   $67.5 \times 60 = 4{,}050$ gallons per minute

6. The B.O.D. (Biochemical Oxygen Demand) of a sewage is 120 p.p.m. The stream into which it will be discharged has a dissolved oxygen content of 15 p.p.m. What percentage of purification will the sewage have to undergo before the effluent may be allowed to empty into the stream if the dissolved oxygen in the stream is not to fall below 6 p.p.m. Assume the sewage is discharged at a rate of 500 gallons per minute and the stream flow is 2500 gallons per minute (g.p.m.). The total stream flow below the sewage outfall is 3,000 g.p.m. of which 1/6 is sewage and 5/6 is dilution water. The stream will furnish 5 parts and the sewage one part of the total flow of 6 parts. The desired residual oxygen is 6 p.p.m. The stream can furnish 5 (15-6) = 45 p.p.m. of oxygen. The sewage will need 120 + 6 = 126 p.p.m. of oxygen in order to neutralize the demand of the sewage and also furnish a residual of 6 p.p.m. of oxygen. The amount of oxygen that must be furnished by the treatment plant is then 126 - 45 = 81 p.p.m. Since removing that much oxygen demand would give the same result as furnishing that much oxygen, 81 parts of oxygen demand would have to be removed from the total sewage demand of 120 parts which means the plant would have to give

$\frac{81}{120} \times 100 = 67.5\%$ purification.

Useful Memoranda and Formulas

(From - Sanitary Inspector's Handbook - Clay)

WATER (H_2O)

1 gallon of water weighs 8.34 pounds.
1 cubic foot of water equals 7.48 gallons.
1 cubic foot of water weighs 62.4 pounds.
"Head" of water is the vertical height of the water surface above any given point. This is always expressed in feet.
Under a given head, water presses equally in all directions (Pascal's Law).
Water is the standard for specific gravity of liquids and solids. Specific gravity of water is 1.0.
Boiling point is 212°F. or 100° C.
Freezing point is 32°F. or 0°C.
Latent heat of vaporization is 966 British Thermal units or 536.6 calories at 100°C.
Latent heat of fusion is 144 British Thermal units or 80 calories at 0°C.
Expansion from point of maximum density (at 4°C) to boiling point is 1/23 of bulk.
One cubic inch of water evaporated under an atmosphere of pressure is converted into approximately one cubic foot of steam, or an approximate increase of 1600 times of volume.
Head of water x 0.433 equals pounds per square inch. 0.433 equals weight (in pounds) of a column of water 1 square inch in section and 12 inches in height.
Head of water x 62.4 equals pounds per square foot.
Head of water x 0.34 equals pounds per circular inch.
0.041 equals gallons contained in 1 foot of 1 inch pipe.
Diameter of pipe or cylinder in inches squared x 0.041 equals gallons per foot run.
Diameter of wells, etc., in feet squared x 5.(equals gallons per foot of depth)(Approximately)
The relative discharging powers of pipes are as the square root of the fifth power of their diameters:
Discharge of water through pipes: $G = \sqrt{\frac{(3d)^5 \times H}{L}}$

G = No. gallons discharged per minute
D = Diameter of pipe in inches
H = Head of water in feet
L = Length of pipe in yards

The relative capacities of pipes are as the square of their diameter.
Hydraulic Mean Depth is the sectional area of flow divided by the wetted perimeter.
Hydraulic Gradient varies with diameter, fall, and volume of flow. It may be said to be the height to which water would rise under its own head at various points along a line of pipe running full bore.
Hydraulic Mean Gradient is the total length (measured horizontally) divided by the total fall.

HEAT

1°C is equal to 1.8°F.
To convert Centigrade to Fahrenheit, multiply the Centigrade reading by 9/5 and add 32.
To convert Fahrenheit to Centigrade, subtract 32 from the Fahrenheit reading and multiply by 5/9.
Specific Heat is the amount of heat necessary to raise one gram of a substance 1°C.
Latent Heat is the amount of heat given out or absorbed by a substance in the act of changing from one state to another e.g. water to ice.
British Thermal Unit (B.T.U.) is the amount of heat required to raise 1 pound of water at the point of maximum density (39.2°F) through 1°F., or more correctly 1/180 of the heat required to raise 1 pound of water from 32°F. to 212°F.
Calorie is the amount of heat required to raise 1 Kilogram of water through 1°C; or more correctly from 0°C. to 1°C. (This is the large calorie).
Calorie is the amount of heat required to raise 1 gram of water through 1°C; or more correctly from 15°C. to 16°C. (This is the small calorie).
Therm is 100,000 British Thermal Units.

AIR

1 cubic foot of air at temperature of 62°F., and at an atmospheric pressure of 14.7 pounds weighs 0.076097 pounds.
1 pound of air at a temperature of 62°F., and an atmospheric pressure of 14.7 pounds is

13.141 cubic feet in volume.
Volume varies inversily as the pressure (Boyles Law).
Volume increases approximately 1/491 for each degree F. rise in temperature (Charles Law).
Mean pressure of the atmosphere is 14.7 pounds per square inch at sea-level. (This equals one atmosphere).

MENSURATION RULES

Circumference of circle is equal to diameter x π(3.1416)
Area of circle equals diameter squared x 0.7854 or radius squared x π(3.1416)
Area of ellipse equals major axis x minor axis x 0.7854.
Solid contents of a cylinder equals length x area of cross section.
Solid contents of cone equals area of base x 1/3 vertical height.
Solid contents of frustum of cone equals the sum of the areas of the two ends plus the square root of their product; multiply the sum thus obtained by 1/3 the vertical height.
Surface area of cylinder equals circumference x length + areas of the two ends.
Surface of hemisphere equals diameter x height x 3.1416.
Surface area of sphere equals diameter squared x 3.1416 or $4\pi R^2$.
The area of the curved surface of a frustum of a cone equals the sum of the circumferences of the two ends of the frustum x 1/2 slant height of the frustum.

TABLES

Linear Measure

BRITISH

12 inches	=	1 foot
3 feet	=	1 yard
$5\frac{1}{2}$ yards	=	1 pole
22 yards	=	1 chain
40 poles	=	1 furlong
10 chains	=	1 furlong
8 furlongs	=	1 mile
80 chains	=	1 mile
3 miles	=	1 league

METRIC

10 millimeters (M.M.)	=	1 centimeter (C.M.)
10 centimeters	=	1 decimeter (D.C.M.)
10 decimeters	=	1 meter (M)
10 meters	=	1 dekameter (DKM).
10 dekameters	=	1 hektometer (HKM)
10 hektometers	=	1 kilometer (KM)

Table of Equivalents

BRITISH		METRIC
1 inch	=	2.5399 centimeters
1 foot	=	30.479 centimeters
1 yard	=	0.914 meter
1 mile	=	1.609 kilometers

METRIC		BRITISH
1 millimeter	=	0.0394 inch
1 centimeter	=	0.3937 inch
1 meter	=	39.3708 inches
1 kilometer	=	0.6214 mile

SURVEYOR'S LINEAR MEASURE

1 inch	=	7.92 inches
25 links	=	1.0 rod
100 links	=	1.0 chain
1 chain	=	66.0 feet
80 chains	=	1.0 mile

SURVEYOR'S SQUARE MEASURE

625 sq. links	=	1 sq. rod
16 sq. rods	=	1 sq. chain
10 sq. chains	=	1 acre
640 acres	=	1 sq. mile
1 sq. mile	=	6,400 sq. chains
1 sq. chain	=	484 sq. yards
1 sq. chain	=	10,000 sq. links

BRITISH SQUARE MEASURE

144 square inches	=	1 square foot
9 square feet	=	1 square yard
30.25 square yards	=	1 rod, pole, perch
40 poles	=	1 rood
4 roods	=	1 acre
640 acres	=	1 square mile

METRIC SQUARE MEASURE

100 sq. millimeters	=	1 sq. centimeter
100 sq. centimeters	=	1 sq. decimeter
100 sq. decimeters	=	1 sq. meter
100 sq. meters	=	1 sq. dekameter
100 sq. dekameters	=	1 sq. hektometer
100 sq. hektometers	=	1 sq. kilometer

Cubic Measure

BRITISH

1728 cubic inches	=	1 cubic foot
27 cubic feet	=	1 cubic yard

METRIC

1000 cubic millimeters	=	1 cubic centimeter
1000 cubic centimeters	=	1 cubic decimeter
1000 cubic decimeters	=	1 cubic meter
1000 meters	=	1 cubic dekameter
1000 dekameters	=	1 cubic hektometer
1000 hektometers	=	1 cubic kilometer

EQUIVALENTS

1 cubic inch	=	16.387 cubic centimeters
1 cubic centimeter	=	0.061 cubic inch
1 square inch	=	6.451 square centimeters
1 square foot	=	9.29 square decimeters
1 square mile	=	2.599 square kilometers
1 square meter	=	10.764 square feet
1 square kilometer	=	0.3861 square mile

<u>Avoirdupois Weight</u>

BRITISH

16 drams	=	1 ounce
16 ounces	=	1 pound
28 pounds	=	1 quarter
4 quarters	=	1 hundredweight
20 hundredweights	=	1 ton

METRIC

10 milligrams	=	1 centigram
10 centigrams	=	1 decigram
10 decigrams	=	1 gram
10 grams	=	1 decagram
10 decagrams	=	1 hectogram
10 hectograms	=	1 kilogram
10 kilograms	=	1 myriagram
10 myriagrams	=	1 quintal
10 quintals	=	1 tonne

EQUIVALENTS

1 milligram	=	approximately 1/65 grain
1 gram	=	approximately 15½ grains
1 kilogram	=	approximately 2-1/5 pounds
1 metric tonne	=	approximately 1 ton

CIRCULAR MEASURE

60 seconds (")	=	1 minute (')
60 minutes	=	1 degree (o)
90 degrees	=	1 right angle
360 degrees	=	1 circle
1/4 circle	=	1 quadrant
1/6 circle	=	1 sextant

<u>Conversion Tables</u>

To Convert:	
Inches to centimeters	Multiply by 2.54
Yards to meters	Multiply by 0.9
Miles to kilometers	Multiply by 1.6
Square inches to square centimeters	Multiply by 6.45
Cubic inches to cubic centimeters	Multiply by 16.4
Pounds to kilograms	Multiply by 0.45
Cubic meters to cubic feet	Multiply by 35.3
Cubic feet to cubic meters	Multiply by 0.03
Cubic yards to cubic meters	Multiply by 0.76
Centimeters to inches	Multiply by 0.4
Meters to yards	Multiply by 1.1
Kilometers to miles	Multiply by 0.62
Square centimeters to square miles	Multiply by 0.155
Cubic centimeters to cubic inches	Multiply by 0.06
Cubic feet of water to pounds	Multiply by 62.4
Pounds of water to cubic feet	Multiply by 0.016
Cubic feet of water to gallons	Multiply by 7.48
Gallons of water to cubic feet	Multiply by 0.134
Gallons of water to pounds	Multiply by 8.34
Pounds of water to gallons	Multiply by 0.12
Gallons of water to liters	Multiply by 3.8
Liters of water to gallons	Multiply by 0.26

BOOKS, JOURNALS AND PAMPHLETS FOR SANITARIANS

BOOKS:

1. Municipal and Rural Sanitation - V. M. Ehlers and E. W. Steel.
2. Preventive Medicine and Hygiene - M. J. Rosenau.
3. Public Health Engineering - E. B. Phelps.
4. Sedgwick's Principles of Sanitary Science & Public Health - S. C. Prescott & H. P. Horwood.
5. Sewerage and Sewage Disposal - L. Metcalf & H. P. Eddy.
6. Water Supply and Sewage - E. W. Steel.
7. Louisiana State Sanitary Code.
8. Public Health Law - J. A. Tobey.
9. The Evolution and Significance of the Modern Public Health Campaign - C.E.A. Winslow
10. Dairy Science - W. E. Peterson.
11. Sanitary Inspector's Handbook - H. H. Clay.
12. Rural Health Practice - H. Mustard.
13. Housing for Health - American Public Health Association.
14. Elementary Bacteriology - J. E. & E. O. Greaves - W. B. Saunders - Philadelphia.

BULLETINS:

1. Camp Sanitation - C. A. Holmquist & C. R. Cox, N.Y. State Dept. of Health.
2. Ground-Water Supplies - Public Health Reports, Supplement #124.
3. Report of the Joint Committee on Bathing Places - Public Health Reports, Supplement #139.
4. A Guide to the Identification of the Common Mosquitoes of the Southeastern U. S. - Public Health Reports Reprint #836.
5. The Control of Communicable Diseases - Public Health Reports, Reprint #1697.
6. The Rat and Ratproof Construction of Buildings - Public Health Reports, Supplement, #131.

PAMPHLETS AND BOOKLETS:

1. Report on Economic Condition of the South - Nat'l. Emergency Council, Washington,D.C.
2. Malaria Control for Engineers - American Society of Civil Engineers,33 W.39th St.,N.Y.
3. The Effect of Illumination on the Eyes - National Better Light - Better Sight Bureau, 420 Lexington, New York.
4. Methods & Standards for the Production of Certified Milk - The American Assn. of Medical Milk Commissions,Inc.,1265 Broadway,N.Y.
5. U. S. P. H. S. Milk Ordinance and Code - U.S.P.H.S., Washington, D. C.
6. Dairy, Milk and Milk Products Regulations of Louisiana - La. State Board of Health.
7. U. S. P. H. S. Ordinance and Code Regulating Eating & Drinking Establishments.
8. U. S. P. H. S. Minimum Requirements for Endorsement of State Shellfish Control Measures and Certificates for Shippers in Interstate Commerce.
9. Essentials of Field Sanitation - Medical Field Service School, Carlisle Barracks,Pa.
10. Sanitation of Camps and Stations - Special Text #59, Supt. of Documents,Washington,D.C.
11. Food, Drugs, and Cosmetic Code of Louisiana.
12. Food, Drugs, and Cosmetic Code of the Federal Government.
13. Water Supply and Treatment - Nat'l Lime Association, Washington, D. C.
14. Sewage Treatment - Nat'l. Lime Association, Washington, D. C.

JOURNALS:

1. Health Officers News Digest - Public Health Committee of the Cup and Container Institute - 50 Rockefeller Plaza, N.Y.
2. American Journal of Public Health - 50 West 50th St., New York.
3. U. S. Public Health Reports - U.S.P.H.S., Washington, D. C.
4. The Sanitarian - 670 S. Ferris Ave., Los Angeles, California.
5. Public Health Engineering Abstracts - U.S.P.H.S., Washington, D. C.
6. Survey Graphic - 54 N. Crystal Street, East Stroudsburg, Pa.
7. The Johnson National Drillers Journal - St. Paul, Minn.

SEE PUBLICATIONS BY:

1. U. S. Public Health Service.
2. U. S. Labor Department - Children's Bureau
3. U. S. Department of Agriculture.
4. Wallace & Tiernan Co. Inc., Newark, N. J.
5. Metropolitan Life Insurance Co. & Other Insurance Companies.

CONTENTS OF A SANITARIAN'S KIT

1. Three milk thermometers.
   a. Self registering for pasteurization vats
   b. For pasteurization pipe lines
   c. Milk sample temperature
2. A thermometer for room temperature reading.
3. A milk dipper for collecting milk samples from producers' cans.
4. A testing set for checking residual chlorine in drinking water.
5. A testing set for checking Ph of water.
6. A phosphatase testing set, lactometer, sediment tester.
7. A testing set for checking chlorine in dish and equipment sterilization water.
8. A testing set for soaker solution.
9. A lightmeter.
10. A small blow torch or alcohol lamp.
11. Plans and specifications of septic tanks and privies.
12. Plans and specifications of dairy buildings.
13. Plans and specifications of wells, springs, and cisterns.
14. Inspection forms and pencil.
15. A slide rule.
16. A metal measuring tape.
17. A ball of cord.
18. A penknife.
19. Name tags and stickers.
20. Flashlight.

<u>Other Equipment that should be Available</u>

1. Milk sample case for 12 to 20 pint bottles.
2. Water sample case.
3. A set for reductase milk test (including alcohol lamp).
4. A set for Babcock butterfat test.
5. A lactometer.
6. Set of carpenter tools.
7. Metal riser forms.
8. Milk ledger for keeping all records of inspections.

Index

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SUPPLEMENT I

SUPPLEMENT II

SUPPLEMENT III

SUPPLEMENT I

STATE OF LOUISIANA

Act 142 of 1936

As Amended by Act 185 of 1942

The State Food, Drugs and Cosmetic Act

LOUISIANA
STATE BOARD OF HEALTH

DAVID E. BROWN, M. D.

New Orleans, La.

5M—9-42

ACT No. 142

House Bill No. 347. By Mr. Morvant.

AN ACT

To prevent the adulteration, substitution, misbranding and false advertising of food, drugs, devices, and cosmetics, and to provide for the registration, investigation and examination of same, and the cost incident thereto, by the Louisiana State Board of Health, for the purpose of safeguarding public health, preventing deceit upon the purchasing public, providing that all monies collected under the provisions of this Act, shall be used for the maintenance and enforcement of this Act, providing penalties for the violation of this Act, and repealing all laws in conflict herewith, and for other purposes.

Section 1. Be it enacted by the Legislature of Louisiana, that this Act may be cited as the "State Food, Drugs, and Cosmetic Act."

State Food, Drugs and Cosmetic Act.

DEFINITION OF TERMS

Section 2. As used in this Act, unless the context otherwise indicates—

Definitions.

(a) The term "food" includes all substances and preparations used for, or entering into the composition of food, drink, confectionery, chewing gum, or condiment for man or other animals.

(b) The term "drug," for the purpose of this Act includes (1) all substances and preparations recognized in the official United States Pharmacopoeia, official Homeopathic Pharmacopoeia of the United States, or official National Formulary, or any supplement to any of them; and (2) all substances and preparations intended for use in the diagnosis, cure, mitigation, treatment, or prevention of disease in man or other animals; and (3) all substances, and preparations, other than food and cosmetics, intended to affect the structure or any function of the body.

(c) The term "device," for the purposes of the Act includes all devices intended (1) for the use in diagnosis, cure, mitigation, treatment, or prevention of disease in man or other animals; and (2) to affect the structure or any function of the body.

(d) The term "cosmetic" includes all substances and preparations intended for cleansing, or altering the appearance of, or promoting the attractiveness of the person; except that such term shall include soaps only when medicinal or curative qualities are claimed therefor.

(e) The term "person" includes individual, partnership, corporation, and association.

(f) The term "President" means the President of the State Board of Health.

(g) The term "label" means the principal display or displays of written, printed, or graphic matter (1) upon any food, drug, device, or cosmetic, or the immediate container thereof, and (2) upon the outside container or wrapper, if any there be, of the retail package of any food, drug, device, or cosmetic.

(h) The term "labeling" includes all labels and other written, printed, and graphic matter, in any form whatsoever, accompanying any food, drug, device, or cosmetic.

(i) The term "advertisement" includes all representations of fact or opinion disseminated to the public in any manner or by any means other than by the labeling.

(j) The term "medical profession" means the legalized professions of the healing art; and the term "medical opinion" means the opinion, within their respective fields, of the practitioners of any branch of the medical profession, the practice of which is licensed by law in the State of Louisiana; and the term "scientific opinion" means the opinion, within their respective fields, of competent pharmacologists, physiologists, or toxicologists.

(k) The term "official compendium" means the United States Pharmacopoeia, Homeopathic Pharmacopoeia of the United States, National Formularly, or any supplement to any of them, official at the time any drug to which the provisions thereof relate is introduced into commerce.

(l) The term "Board" means the State Board of Health.

ADULTERATED FOOD

Adulterated food defined.

Section 3. A food shall be deemed to be adulterated if it has been found to be such by any department of the United States Government, or:

(a) (1) If it bears or contains any poisonous or deleterious substances which may render it dangerous to health; or (2) if it bears or contains any added poisonous or added deleterious substance which may render it injurious to health, or which is prohibited by Section 6, or in excess of the limits of tolerance prescribed by regulations as provided by Sections 6 and 15; or (3) if it consists in whole or in part of any filthy, putrid, or decomposed substance, or if it is otherwise unfit for food; or (4) if it has been prepared, packed, or held under insanitary con-

ditions whereby it may have become contaminated with filth, or whereby it may have been rendered injurious to health; or (5) if it is the product of a diseased animal or of an animal which has died otherwise than by slaughter; or (6) if its container is composed of any poisonous or deleterious substance which may render the contents injurious to health.

The Board shall promulgate sanitary regulations for carrying the provisions in (3) and (4) of this sub-section (a) into effect. Provided that for the first charge of finding thereunder the person, firm or corporation shall be given a notice and hearing and a notice to correct the insanitary conditions or the unsanitary food complained of; and provided further that such notice and order shall not be construed to prohibit the seizure as provided in this Act of food dangerous to health.

(b) (1) If any valuable constituent has been in whole or in part abstracted therefrom; or (2) if any substance has been substituted wholly or in part therefor; or (3) if damage or inferiority has been concealed in any manner; or (4) if any substance has been added thereto or mixed or packed therewith so as to increase its bulk or weight, or reduce its quality or strength, or create a deceptive appearance.

(c) If it contains a coal-tar color other than one from a batch that has been certified in accordance with regulations as provided by Sections 6 and 15. Such certificate shall contain the physiological factor or factors tested and give notice that only such factor or factors have been tested. No persons, firm or corporation shall use such certificate in the label or advertising of any food.

(d) If it is confectionery or ice cream, it shall also be deemed to be adulterated if it bears or contains any alcohol, resinous glaze, or nonnutritive substance except harmless coloring, harmless flavoring, natural gum, and pectin: Provided, that this paragraph shall not apply to any confectionery or ice cream by reason of its containing less than one-half of 1 per centum by volume of alcohol derived solely from the use of flavoring extracts, or to any chewing gum by reason of its containing harmless nonnutritive masticatory substance.

MISBRANDED FOOD

Section 4. A food shall be deemed to be misbranded if it has been found to be such by any department of the United States Government, or: Misbranded food defined.

(a) If its labeling is false or misleading in any particular.

(b) If it is offered for sale under the name of another food.

(c) If it is an imitation of another food, and its label fails to bear, in type of uniform size and prominence, the word "imitation" and, immediately thereafter, the name of the food imitated.

(d) If its container is so made, formed, or filled as to mislead the purchaser.

(e) If in package form unless it bears a label containing (1) the name and place of business of the manufacturer, packer, seller, or distributor; and (2) an accurate statement of the quantity of the contents in terms of weight, measure, or numerical count: Provided, That under subdivision (2) of this paragraph reasonable variations shall be permitted, and exemptions as to small packages shall be established, by regulations prescribed by the Board.

(f) If any word, statement, or other information required on the label under any provision of this Act is not prominently placed thereon in such a manner as to be easily seen and in such terms as to be readily understood by purchasers and users of such articles under customary conditions of purchase and use, due consideration being given to the size of the package.

(g) If it purports to be or is represented as a food for which a definition and standard of identity has been prescribed by regulations as provided by Sections 5 and 15, and (1) it fails to conform to such definition and standard, or (2) its label fails to bear the name of the food prescribed in the defintion and standard, and if so required by such regulations when such definition and standard permits optional ingredients other than spices, flavors, and coloring, the common names of such optional ingredients as are present in such food.

(h) If it purports to be or is represented as a food for which a standard of quality or fill of container has been prescribed by regulations as provided by Sections 5 and 15, and its quality or fill falls below such standard of quality or fill of container and its label fails to bear a statement, in such manner as the regulations specify, showing that it falls below such standard of quality or fill of container.

(i) If it is not subject to the provisions of paragraph (g) of this section and its label fails to bear (1) the common or usual name of the food, if any there be, and (2) in case it is fabricated from two or more ingredients the common or usual name of each such ingredient; except that spices, flavors, and coloring, other than those sold as such, may be designated as spices, flavors, and colorings without naming each. Provided, that, to the extent that compliance with the requirements of sub-division (2) of this paragraph is impracticable because of variations in ingredients usual

to good manufacturing or packing practice, or is impracticable for any other reason, exemptions shall be established by regulations promulgated by the Board. Such sub-division (2) shall not apply to any proprietary food the ingredients of which have been fully and correctly disclosed to the Board if compliance with such sub-division would give competitors information they could not otherwise obtain. The Board shall establish regulations for carrying this Act into effect and publish from time to time the list of ingredients required in this sub-section to be declared on the label provided, however, that such lists shall be within the class of ingredients required to be declared on the label under this sub-section.

(j) If it purports to be or is represented for special dietary uses, such as by infants or invalids or for other special nutritional requirements, and its label fails to bear, statements concerning its vitamin, mineral, and other dietary properties which fully inform the purchaser as to its nutritional value. The Board shall establish regulations for carrying this sub-section (j) of Section 4 into effect including administrative regulations covering vitamin, mineral and other dietary properties, provided that such regulations shall be established in co-operation with the United States Public Health Service and particularly in the work of that service connected with pellagra and other dietary diseases and the feeding of children to the end that the inspection to determine correct labeling shall fully conform to the work of the Public Health Service and to the extent that such is included within the expressed provision therein for labeling.

(k) If it bears or contains any artificial flavor, artificial color, or chemical preservative, and it fails to bear a label stating that fact.

(l) The Board is hereby authorized to promulgate regulations exempting from any labeling requirement of this Act small open containers of fresh fruits and fresh vegetables and also food which is, in accordance with the practice of the trade, processed, labeled, or repacked in substantial quantities at establishments other than those where originally processed or packed, on condition that such food is in conformity with the provisions of this Act upon removal from such processing, labeling, or repacking establishment.

DEFINITIONS AND STANDARDS FOR FOOD

Standards for food.

Section 5. For the effectuation of the purpose of this Act the Board is hereby authorized to promulgate regulations, as provided by Section 15, fixing and establishing for any food a definition and standard of identity, and a reasonable standard of quality or fill of container: Provided, That no standard of quality shall be estab-

lished for fresh fruit and fresh vegetables and no standard of identity for fresh apples and fresh pears: And provided further, that in any regulation pertaining to fill of container the Board shall give due consideration to the natural shrinkage in storage and in transit of fresh natural food and to need for necessary packing and protective material.

TOLERANCE FOR POISONOUS INGREDIENTS IN FOOD AND CERTIFICATION OF COAL-TAR COLORS FOR FOOD

Tolerance for poisonous ingredients and certification of coal-tar colors for food.

Section 6. (a) To safeguard the public health, no poisonous or deleterious substance shall be added to any food except where such substance is required in the production thereof or cannot be avoided by good manufacturing practice; but when such substance is so required or cannot be so avoided, the Board is authorized, for the protection of public health, to promulgate regulations, as provided by Section 15, limiting the quantity therein or thereon. In determining the quantity of such added substance to be tolerated in or on different articles of food the Board shall take into account the extent to which the use of such substance is required or cannot be avoided in the production of each such article, and the other ways in which the consumer may be affected by the same or other poisonous or deleterious substances.

(b) The Board is hereby authorized to promulgate regulations, as provided by Section 15, for the certification of coal-tar colors which are harmless and suitable for use in food.

EMERGENCY PERMIT CONTROL

Emergency permit control.

Section 7. (a) Whenever the Board finds after investigation that the distribution of any class of food may, by reason of contamination with micro-organisms during the manufacture, processing, or packing thereof, be injurious to health, and such injurious nature cannot be adequately determined after such articles have entered state commerce, it is then, and in such case only, authorized to promulgate regulations, as provided by Section 15, governing the condition of manufacture, processing, or packing for such temporary periods of time as may be necessary to protect the public health, and thereafter no manufacturer, processor, or packer of such class of articles shall introduce into state commerce any such food unless he holds an unsuspended, valid permit issued by the Board as provided by the regulations.

(b) The Board is authorized to issue such permits for such periods of time as it may by regulations prescribe and to make regulations governing the issuance and renewal thereof. The

President is authorized to suspend immediately upon notice any permit issued under authority of this section if it is found that any of the conditions of the permit have been violated. The holder of a permit so suspended shall be privileged at any time to apply for the reinstatement of such permit, and the Board shall immediately after prompt hearing and an inspection of the establishment, reinstate such permit if it is found that adequate measures have been taken to comply with and maintain the conditions of the permit, as originally issued or as amended.

(c) Any officer or employee duly designated by the Board shall have access to any factory or establishment, the operator of which holds a permit from the Board, for the purpose of ascertaining whether or not the conditions of the permit are being complied with, denial of access for such inspection shall be ground for suspension of the permit until such access is freely given by the operator.

ADULTERATED DRUGS

Adulterated drugs defined.

Section 8. A drug shall be deemed to be adulterated if it has been found to be such by any department of the United States Government, or:

(a) (1) If it consists in whole or in part of any filthy, putrid, or decomposed substance, or (2) if it has been prepared, packed, or held under insanitary conditions whereby it may have been contaminated with filth, or whereby it may have been rendered injurious to health; or (3) if its container is composed of any poisonous or deleterious substance which may render it injurious to health; or (4) if it contains, for purposes of colorings only, a coal-tar color other than one from a batch that has been certified in accordance with the regulations as provided by Sections 10 and 15.

(b) If its name is recognized in an official compendium, or if it purports to be a drug, the name of which is so recognized, and it differs from the standard of strength, quality, or purity as determined by the tests or methods of assay set forth therein; except that whenever tests or methods of assay have not been prescribed therein, or such tests or methods of assay as are prescribed are insufficient, for determining whether or not such drug complies with such standard, the Board is hereby authorized to bring such fact to the attention of the appropriate body charged with the revision of such compendium and if such body fails within a reasonable time to prescribe tests or methods of assay which are sufficient, then the Board may prescribe for the purposes of this Act such tests or methods of assay by regulations as provided by Section 15. No drug shall be deemed to be adulterated under this paragraph because it differs from the standards of strength, quality

or purity therefor set forth in an official compendium, if its standard of strength, quality, and purity be plainly stated on its label. Whenever a drug is recognized in both the United States Pharmacopoeia and the Homeopathic Pharmacopoeia of the United States it shall be subject to the requirements of the United States Pharmacopoeia unless it is labeled and offered for sale as a homeopathic drug, in which case it shall be subject to the provisions of the Homeopathic Pharmacopoeia of the United States and not to those of the United States Pharmacopoeia.

(c) If it is not subject to the provisions of paragraph (b) of this section and its identity or strength differs from, or its purity or quality falls below, that which it purports or is represented to possess.

(d) If any substance has been (1) mixed or packed therewith so as to reduce its quality or strength or (2) substituted wholly or in part therefor.

MISBRANDED DRUGS AND DEVICES

Misbranded drugs and devices defined.

Section 9. A drug or device shall be deemed to be misbranded if it has been found to be such by any department of the United States Government, or:

(a) If its labeling is false or misleading in any particular. Any representation concerning any effect of a drug or device shall be deemed to be false under this paragraph if such representation is not supported by demonstrable scientific facts or substantial and reliable medical or scientific opinion.

(b) If it is dangerous to health under the conditions of use prescribed in the labeling or advertising thereof.

(c) If in package form it fails to bear a label containing (1) the name and place of business of the manufacturer, packer, seller, or distributor; and (2) an accurate statement of the quantity of the contents in either terms of weight, measure, or numerical count: Provided, That under subdivision (2) of this paragraph reasonable variations shall be permitted, and exemptions as to small packages shall be established, by regulations prescribed by the Board, where compliance with such provisions would be impracticable.

(d) If any word, statement, or other information required on the label under any provision of this Act is not prominently placed thereon in such a manner as to be easily seen and in such terms as to be readily understood by purchasers and users of such articles under customary conditions of purchase and use, due consideration being given to the size of the package.

(e) If it is for use by man and contains any quantity of any of the following narcotic or hypnotic substances: Alpha eucaine, barbituric acid, beta eucaine, bromal, cannabis, carbromal, chloral, coca, cocaine, codeine, heroin, marihuana, morphine, opium, paraldehyde, peyote, sulphomethane, or any substance chemically derived therefrom, except derivatives of coca leaves which do not contain cocaine, ecgonine or substances from which cocaine or ecgonine may be synthesized or made, or any other narcotic or hypnotic substance, which has been designated as habit forming by regulations as provided by Section 15 unless the derivative is clearly not habit forming, and except when dispensed on the written order of a member of the medical profession, its label fails to bear the name and quantity or proportion of such substance or derivative and in juxtaposition therewith the statement "Warning—May Be Habit Forming."

(f) If it is a drug and is not designated solely by a name recognized by an official compendium or if its label has been disapproved by the United States Government or the State Board of Health.

(g) If its name is recognized in an official compendium, or if it purports to be a drug the name of which is so recognized, and it is not packaged and labeled as prescribed therein.

Whenever a drug is recognized in both the United States Pharmacopoeia and the Homeopathic Pharmacopoeia of the United States it shall be subject to the requirements of the United States Pharmacopoeia with respect to packaging and labeling unless it is labeled and offered for sale as a homeopathic drug, in which case it shall be subject to the provisions of the Homeopathic Pharmacopoeia of the United States, and not to those of the United States Pharmacopoeia.

(h) If it is a drug liable to deterioration, and is not packaged in such form or manner, or its label fails to bear a statement of such precautions, as such regulations require for the protection of public health. No such regulations shall be established for any drug recognized in an official compendium until the Board shall have informed the appropriate body charged with the revision of such compendium of the need for such packaging or labeling requirements and such body shall have failed within a reasonable time to prescribe such requirements. The Board shall establish regulations to carry this provision into effect.

(i) (1) If it is a drug and its container is so made, formed, or filled as to mislead the purchaser; or (2) if it is an imitation of another drug; or (3) if it is offered for sale under the name of another drug.

(j) When construing and enforcing the provisions of this Act with respect to labeling and advertisements, the term "antiseptic" shall be deemed to have the same meaning as the word "germicide," except, however, in the case of a drug purporting to be, or represented as, an antiseptic for inhibitory use as a wet dressing, ointment, dusting powder, or such other use as involves prolonged contact with the body.

(k) The Board is hereby directed to promulgate regulations exempting from any labeling or packaging requirement of this Act drugs and devices which are, in accordance with the practice of the trade, processed, labeled, or repacked in substantial quantities at establishments other than those where originally processed or packed, on condition that such drugs and devices are in conformity with the provisions of this Act upon removal from such processing, labeling, or repacking establishment.

CERTIFICATION OF COAL-TAR COLORS FOR DRUGS

Certification of coal-tar colors for drugs.

Section 10. The Board is hereby authorized to promulgate regulations, as provided by Section 15, for the certification of coal-tar colors which are harmless and suitable for use in drugs for purposes of coloring only.

ADULTERATED COSMETICS

Adulterated cosmetics defined.

Section 11. A cosmetic shall be deemed to be adulterated if it has been found to be such by any department of the United States Government, or:

(a) If it bears or contains any poisonous or deleterious substances which may render it injurious to health under such conditions of use as are customary or usual.

(b) If it consists in whole or in part of any filthy, putrid, or decomposed substance.

(c) If it has been prepared, packed, or held under insanitary conditions whereby it may have become contaminated with filth, or whereby it may have been rendered injurious to health.

(d) If its container is composed of any poisonous or deleterious substance which may render it injurious to health.

(e) If it contains a coal-tar color other than one from a batch that has been certified in accordance with regulations as provided by Sections 13 and 15.

MISBRANDED COSMETICS

Section 12. A cosmetic shall be deemed to be misbranded if it has been found to be such by any department of the United States Government, or:

Misbranded Cosmetics defined.

(a) If its labeling is false or misleading in any particular, or if it is injurious to health under the conditions of use prescribed in the labeling or advertising thereof.

(b) If in package form it fails to bear a label containing (1) the name and place of business of the manufacturer, packer, seller, or distributor; and (2) an accurate statement of the quantity of the contents in terms of weight, measure, or numerical count: Provided, That under subdivision (2) of this paragraph reasonable variations shall be permitted, and exemptions as to small packages shall be established, by regulations prescribed by the Board, where compliance with such provisions would be impracticable.

(c) If any word, statement, or other information required on the label under any provision of this Act is not prominently placed thereon in such a manner as to be easily seen and in such terms as to be readily understood by the purchasers and users of such articles under customary conditions of purchase and use, due consideration being given to the size of the package.

(d) The Board is hereby authorized to promulgate regulations excepting from any labeling requirement of this Act cosmetics which are, in accordance with the practice of the trade, processed, labeled, or repacked in substantial quantities at establishments other than those where originally processed or packed, on condition that such cosmetics are in conformity with the provisions of this Act upon removal from such processing, labeling, or repacking establishment.

CERTIFICATION OF COAL-TAR COLORS FOR COSMETICS

Section 13. The Board is hereby authorized to promulgate regulations, as provided by Section 15, for the certification of coal-tar colors which are harmless and suitable for use in cosmetics.

Certification of coal-tar colors for cosmetics.

FALSE ADVERTISEMENT

Section 14. (a) An advertisement of a food, drug, device, or cosmetic shall be deemed to be false if it is false or misleading in any particular regarding such food, drug, device or cosmetic. Any representation concerning any effect of a drug or device shall be deemed to be false under this paragraph if such representation

False advertisement.

is not supported by demonstrable scientific facts or substantial and reliable medical or scientific opinion.

(b) The advertisement of a drug or device representing it to have any therapeutic effect in the treatment of Bright's disease, cancer, tuberculosis, poliomyelitis (infantile paralysis), venereal disease, heart and vascular diseases, or any other diseases for which no known therapeutic effect has been fully established, shall be deemed to be false; except that no advertisement not in violation of paragraph (a) of this section shall be deemed to be false under this paragraph if it is disseminated only to members of the medical or pharmaceutical professions or appears only in the scientific periodicals of these professions, or is disseminated only for the purpose of public-health education by persons not commercially interested, directly or indirectly, in the sale of such drugs or devices.

PROVISIONS AS TO REGULATIONS

Regulations.

Section 15. (a) The authority to promulgate regulations for the efficient enforcement of this Act, is hereby vested in the Board.

Hearings.

(b) Hearings authorized or required by this Act shall be conducted by the Board or such officer or employee as it may designate for the purpose.

COURT REVIEW OF REGULATIONS AND ADMINISTRATIVE ACTIONS

Court review of regulations and administrative actions.

Section 16. The district courts are hereby vested with jurisdiction, on petition by any interested person, (1) to restrain by injunction, temporary or permanent, the enforcement by any officer, representative, or employee of the Board of any regulation promulgated as provided in Section 15 if it is shown that the regulation is unreasonable, arbitrary, or capricious, or not in accordance with the facts or law, and that the petitioner may suffer substantial damage by reason of its enforcement; and (2) to grant appropriate injunctive relief from any act or omission of any officer, representative, or employee of the Board in the administration of this Act, if it has been shown that such act or omission is unreasonable, arbitrary, or capricious, or not in accordance with the facts or law, and that the petitioner may suffer substantial damage thereby.

EXAMINATIONS, INVESTIGATIONS, AND REGISTRATIONS

Section 17. (a) The Board is authorized (1) to conduct examinations and investigations for the purpose of this Act or through officers and employees of the Board; (2) to require all manufacturers, packers, or proprietors of processed foods, proprietary or patent medicines, prophylactic devices, and cosmetics, in package form, to register each separate and distinct product annually with the Board and to supply this Board with a sample of each product upon request; and (3) to assess the manufacturers, packers or proprietors of such products an annual examination and investigation charge; provided that the charge shall not exceed two dollars and fifty cents ($2.50) for any one separate and distinct product registered, and that the total examination and investigation charge to any one manufacturer, packer or proprietor, shall not exceed Ten Dollars ($10.00) annually. Manufacturers, packers, or proprietors of ice cream, soft drinks and non-alcoholic beverages, except non-alcoholic fruit juices shall be exempted from the payment of examination and investigation charges here authorized since they are now required to pay a similar fee under the provisions of Act 214 of 1928 and Act 201 of 1924. Manufacturers, packers, or proprietors of products offered for sale or sold at retail only in their own establishments shall be exempted from the payment of the examination and investigation charges here authorized.

Authority of Board to conduct examinations, investigations, and to provide for registrations.

Assessment of charges.

Exemptions from charges.

(b) All inspection, investigation and examination fees collected by the Louisiana State Board of Health under the provisions of this Act shall be devoted to the expenses of inspections, examinations and investigations conducted under the authority of this Act and for the maintenance and enforcement of the provisions of this Act.

Disposition of funds.

(c) Failure of any manufacturer, packer or proprietor of a product, included in paragraph (a) of this section, to register same with the Board of Health shall cause the sale of such products to be stopped and subject such articles to seizure and condemnation. The submission of a catalog and specimens of labels shall be required at the time of application for registration of products produced, packaged and prepared in compliance with the requirements of the Federal Food, Drug and Cosmetic Act, which will constitute satisfactory compliance for registration of such products: Provided, that with respect to all other products submission of a catalog and specimens of labels shall be required at the time of application for registration, but registration will not become effective until examination and approval of the label or product by the Board, and which approval must be by written notification to manufacturer, packer or processor. (Amended by Act 185 of 1942.)

Submission of labels.

Registration may be refused.

RECORDS OF INTERSTATE SHIPMENTS

Records of interstate shipments subject to inspection.

Section 18. For the purpose of enforcing the provisions of this Act, carriers engaged in interstate commerce, and persons, receiving food, drugs, devices, or cosmetics in interstate commerce, shall, upon the request of an officer or employee duly designated by the Board, permit such officer or employee to have access to and copy all records showing the movement in interstate commerce of any food, drug, device, or cosmetic, and the quantity, shipper, and consignee thereof; and it shall be unlawful for any such carrier or person to fail to permit such access to and copying of any such record so requested when such request is accompanied by a definite statement in writing specifying the nature or kind of food, drug, device, or cosmetic to which such request relates: Provided, That evidence obtained under this section shall not be used in a criminal prosecution of the person from whom obtained; Provided further, That carriers shall not be subject to the other provisions of this Act by reason of their receipt, carriage, or delivery of food, drugs, devices, cosmetics or advertising matter in the usual course of business as carriers.

FACTORY INSPECTION

Inspection of factories authorized.

Section 19. In order to prevent commerce in adulterated or misbranded food, drugs, devices, or cosmetics for the purposes of safeguarding the public health and preventing deceit upon the purchasing public, officers, or employees duly designated by the Board, after making reasonable request, are authorized (1) to enter any factory, warehouse, or establishment in which food, drugs, devices, or cosmetics are manufactured, processed, packed, or held for storage or shipment in commerce or are held after such shipment, or to enter any vehicle being used to transport such food, drugs, devices, or cosmetics in commerce; and (2) to inspect such factory, warehouse, establishment, or vehicle and all pertinent equipment, finished and unfinished materials, containers, and labeling therein. Any such owner, operator, or custodian who refuses such reasonable request shall be guilty of a misdemeanor and shall on conviction thereof, be subject to the penalties prescribed by this Act.

PROHIBITED ACTS AND PENALTIES

Violations.

Section 20. (a) The following acts and the causing thereof are hereby prohibited:

(1) The introduction or delivery for introduction into commerce of any food, drug, device, or cosmetic that is adulterated or misbranded.

(2) The adulteration or misbranding of any food, drug, device, or cosmetic in commerce.

(3) The receipt in commerce of any food, drug, device, or cosmetic that is adulterated or misbranded, and the delivery or proffered delivery thereof in the original unbroken package for pay or otherwise.

(4) The dissemination of a false advertisement by any means for the purpose of inducing, directly or indirectly, the purchase of food, drugs, devices, or cosmetics.

(5) The introduction into commerce of any food if the manufacturer, processor, or packer does not hold any unsuspended valid permit when so required by regulations.

(6) The refusal to permit access to or copying of any records as required.

(7) The forging, counterfeiting, simulating, or falsely representing or without proper authority using any mark, stamp, tag, label, or other identification device authorized or required by regulations promulgated under the provisions of this Act.

(8) The using by any person to his own advantage, or revealing, other than to the Board or its officers or employees or to the courts when relevant in the trial of any case under this Act, any information acquired under authority of Section 7 or 19 concerning any method of process which as a trade secret is entitled to protection.

(9) The removal or disposal of a detained or seized article, contrary to the provisions of Section 23 of this Act.

Penalties.

(b) Any person who violates any of the provisions of this Act shall be guilty of a misdemeanor and shall on conviction thereof be subject to imprisonment for not more than one year and a fine of not more than $1,000.00, or both such imprisonment and fine; and for a second or subsequent offense imprisonment for not more than two years, or a fine of not more than $3,000.00, or both such imprisonment and fine: Provided: However, that any person who violates any of the provisions of subdivision (4) of paragraph (a) of this section shall only be liable for and forfeit and pay a penalty of not more than $1,000.00 if (1) the violation does not involve imminent danger to health or gross deception, and (2) the violation is established by opinion evidence only.

Responsibility of advertising agency.

(c) No publisher, radio-broadcast licensee, advertising agency, or any other agency or medium for dissemination of advertising shall be deemed to have violated the provisions of subdivision (4) of paragraph (a) of this section by reason of the dissemination of any false advertisement when such dissemination is caused by the manufacturer, packer, distributor, or seller residing in Louisiana, of the article so advertised; but such manufacturer, packer, distributor, or seller shall be amenable to the prosecution and penalties provided for such violations of such subdivision. It shall be unlawful for any publisher, radio-broadcast licensee, advertising agency, or other agency or medium for the dissemination of advertising wilfully to refuse, on reasonable request of an officer or employee duly designated by the Board, to furnish to such officer or employee the name and post-office address of the manufacturer, packer, distributor, or seller, residing in Louisiana, who caused him to disseminate any such advertisement; any publisher, radio-broadcast licensee, advertising agency, or other agency or medium for the dissemination of advertising who so refuses shall be guilty of a misdemeanor and shall on conviction thereof be subject to the penalties prescribed by paragraph (b) of this Section.

Exemptions from penalties.

(d) No dealer shall be subject to the penalties of paragraph (b) of this section; (1) for having received any article of food, drug, device or cosmetic and in good faith sold it as received unless he refuses to furnish on request of an officer or employee duly designated by the Board the name and address of the person from whom he purchased or received such article and all documents pertaining to the delivery of the article to him, or (2) if he established a guaranty of undertaking signed by the person residing in Louisiana from whom he received in good faith the article of food, drug, device, or cosmetic, or advertising copy thereof, to the effect that such article is not adulterated or misbranded, such copy is not false, within the meaning of this Act, designating it. To afford protection such guaranty or undertaking shall contain the name and address of the person furnishing such guaranty or undertaking, and such person shall be amenable to the prosecution and penalties which would attach in due course to the dealer under the provisions of this Act. (Amended by Act 185 of 1942.)

LIABILITY OF CORPORATIONS AND THEIR OFFICERS

Section 21. (a) When construing and enforcing the provisions of this Act, unless otherwise provided, the act, omission, or failure of any officer, employee, or agent acting for or employed by any person, within the scope of employment or office, shall in every case be deemed to be the act, omission, or failure of such person, as well as that of the officer, employee, or agent.

Liability of corporations and their officers.

(b) Whenever a corporation or association violates any of the provisions of this Act, unless otherwise provided, such violation shall also be deemed to be a violation by the individual directors, officers, or agents of such corporation or associations who personally ordered, or did any of the acts constituting, in whole or in part, such violation.

INSTITUTION OF CRIMINAL PROCEEDINGS

Section 22. Before reporting any violation of this Act to any district attorney for institution of criminal proceedings thereunder, the Board shall, in accordance with regulations prescribed by it, afford appropriate notice and opportunity for hearing to interested persons upon the question of such violations. The report shall be accompanied by findings of the appropriate officers and employees. Nothing in this Act shall be construed as requiring the Board to report for prosecution minor violations of this Act whenever it believes that the purposes of the Act can best be accomplished by a suitable written notice or warning.

Institution of criminal proceedings.

SEIZURE

Section 23. (a) Any article of food, drug, device or cosmetic that is adulterated, misbranded or unregistered, or has been manufactured, processed, or packed in a factory or establishment, the operator of which did not, at the time of manufacture, processing or packing, hold an unsuspended valid permit, if so required under Section 7, shall be liable to seizure and condemnation by the Board or such officer or employee as it may designate for the purpose.

Right of seizure and condemnation.

(b) Whenever a duly authorized officer or employee of the Board of Health finds or has probable cause to believe that any food, drug, device or cosmetic, is adulterated, misbranded or unregistered, or has been manufactured, processed, or packed in a factory or establishment, the operator of which did not, at the time of manufacture, processing or packing, hold an unsuspended valid permit, if so required under Section 7, the officer or employee of the Board of Health, so designated shall affix to such article a tag,

Tagging seized goods.

Removal of seized goods unlawful.

stamp or other appropriate marking, giving notice that such article is, or is suspected of being adulterated, misbranded, unregistered or has been manufactured, processed or packed in a factory or establishment, the operator of which did not, at the time of manufacture, processing or packing hold an unsuspended valid permit, if so required under Section 7, and has been detained and seized by the Board of Health, and warning all persons not to remove or dispose of such article by sale or otherwise, until permission of the Board or court of any jurisdiction in which the article is detained or seized, is given. It shall be unlawful for any person to remove or dispose of such detained or seized article by sale or otherwise without permission of the Board or Court of competent jurisdiction.

Court order of condemnation or sale.

(c) When any article detained or seized under this section has been found by the Board to be adulterated, misbranded, or unregistered, or has been found to have been manufactured, processed, or packed in a factory or establishment the operator of which did not, at the time of manufacture, processing or packing, hold an unsuspended valid permit, if so required under Section 7, the Board shall petition the Judge of any Court of competent jurisdiction for an order of condemnation, or sale, as the Court may direct, and the proceeds thereof, if sold, less the legal costs and charges, shall be paid into the State Treasury to the credit of the general fund, but such goods shall not be sold contrary to the provisions of the Act: Provided, however, that upon the payment of the costs of such a proceeding and the execution and delivery of a good and sufficient bond to the effect that such goods shall not be sold or otherwise disposed of contrary to the provisions of this Act, the Board or Court having competent jurisdiction may order and direct that such goods shall be delivered to the owner thereof. When the article seized under this Section is not adulterated, misbranded, or unregistered, the tag or other marking shall be removed by the Board of Health or officer or employee so designated.

Release under bond for reconditioning.

Destruction of perishable foods in violation of the law.

(d) Whenever the Board of Health or duly authorized officer or employee of the Board, as it may designate for the purpose, shall find in any factory, establishment, structure or vehicle of transportation, any meat, sea food, poultry, vegetables, fruit or other perishable article which are unsound or contain any filthy, decomposed or putrid substance, or that may be poisonous or deleterious to health or otherwise unsafe for human consumption, the same being hereby declared a nuisance, such officer or employee of the Board of Health as it may designate, shall forthwith condemn and/or destroy the same, or in any other manner render the same unconsumable as human food. (Amended by Act 185 of 1942.)

INJUNCTION PROCEEDINGS

Section 24. (a) In order to avoid multiplicity of criminal prosecutions, the district courts are hereby vested with jurisdiction for cause shown, to restrain by injunction, temporary or permanent, any person from the repetitious (1) introduction or causing to be introduced into commerce any adulterated, misbranded, or unregistered food, drug, device, or cosmetic; or (2) dissemination of or causing to be disseminated a false advertisement by any means for the purpose of inducing, directly or indirectly, the purchase of food, drugs, devices, or cosmetics in commerce. In such injunction proceedings it shall not be necessary to show on the part of such person an intent to continue the offense.

Injunction proceedings.

(b) Violation of any injunction issued pursuant to this section shall be summarily tried and punished by the court as a contempt. Such contempt proceedings may be instituted by order of the court or by the filing of any information by the District Attorney; and process of the court for the arrest of the violator may be served at any place in the State. No person shall be deemed to have violated an injunction, issued pursuant to this section, by reason of the dissemination, subsequent to such injunction, of the false advertisement which was the basis of the injunction, if such dissemination was beyond the control of such person.

DUTIES OF DISTRICT ATTORNEY

Section 25. It shall be the duty of each District Attorney to whom the Board reports any violation for institution of criminal, or injunction proceedings under this Act, or to whom any health, food, or drug officer of the State, or political subdivision thereof, presents evidence satisfactory to the District Attorney of any such violation, to cause appropriate proceedings to be instituted in the proper courts without delay.

Duties of District Attorney.

PUBLICITY

Section 26. The Board shall cause to be published from time to time reports summarizing all judgments, decrees, and court orders which have been rendered, including the nature of the charge and the disposition thereof.

Reports to be published.

(b) The Board may also cause to be disseminated information regarding food, drugs, devices, or cosmetics in cases involving imminent danger to health or gross deception of the consumer. Nothing in this section shall be construed to prohibit the Board from collecting, reporting, and illustrating the result of its investigations.

SEPARABILITY CLAUSE

Constitutionality.

Section 27. If any provision of this Act is declared unconstitutional, or the applicability thereof to any person or circumstances is held invalid, the constitutionality of the remainder of the Act and the applicability thereof to other persons and circumstances shall not be affected thereby.

REPEAL CLAUSE

Repealing clause.

Section 28. That all laws or parts of laws in conflict with the provisions of this Act be, and the same are, hereby repealed.

Approved by the Governor: July 6, 1936.

A true copy:

E. A. CONWAY,

Secretary of State.

Amendments approved by the Governor July 11, 1942.

Amendments—A true copy:

JAS. A. GREMILLION,

Secretary of State.

SUPPLEMENT II

STATE OF LOUISIANA

Act No. 202 of 1942

ENRICHMENT OF FLOUR AND BREAD

Louisiana
State Board of Health
DAVID E. BROWN, M. D.
New Orleans, La.

ENRICHMENT OF FLOUR AND BREAD

ACT No. 202 OF 1942

House Bill No. 838 **By Mr. Toler**

AN ACT

To regulate the manufacture, baking, mix, compound, sale or offer for sale for human consumption of flour and bread as defined herein, and to require the enrichment of flour and bread by the addition of certain vitamins and minerals and to prescribe the methods of enrichment; authorizing the President of and the Louisiana State Board of Health, to change, or add to, the specifications for ingredients and amounts thereof; providing the method of enrichment; and authorizing the Louisiana State Board of Health to prescribe rules and regulations as prescribed herein to carry out the provisions of this Act; authorizing the Louisiana State Board of Health to determine the availability of the necessary ingredients; defining the terms used herein; fixing active enforcement date; and to fix penalties for violation of same.

Whereas, There exists a widespread deficiency of certain ingredients in foods necessary to the health and well-being of the people, and it is, therefore, necessary and advisable to protect so far as may be possible the health of the people of this State against such deficiency by providing for the addition of such necessary ingredients, normally present in wheat, to certain kinds of flour and bread, and to provide formulas for such addition and rules for its enforcement.

Section 1. Be it enacted by the Legislature of Louisiana that when used in this Act,

(a) The term "flour" includes and shall be limited to flour of every kind and description made wholly or partly from wheat which conforms to the definitions and standards of identity of flour, white flour, wheat flour and plain flour as promulgated by the Federal Security Agency (Federal Register, Vol. 6, pp. 2574-82, May 27, 1941), but excludes whole wheat flour made only from the whole wheat berry with no part thereof removed, and also excludes special packaged flours not used for bread making, such as cake, pancake, cracker, and pastry flours;

(b) The term "bread" includes and shall be limited to bread of every kind and description made wholly or partly from wheat flour which conforms to the definition and standard of identity of bread as promulgated by the Federal Security Agency (Federal Register, Vol. 6, pp. 2771-72, June 7, 1941), but excludes bread containing no wheat flour or breads made from whole wheat flour;

(c) The term "enrichment" as applied to flour or bread means the addition thereto of vitamins and other ingredients of the nature required by this Act; and the terms "enriched flour" (as defined in Federal Regis-

ter, Vol. 6, pp. 2579-81, May 27, 1941, and "enriched bread" (as defined in Federal Register, Vol. 6, pp. 2772, June 7, 1941) mean flour or bread, as the case may be, which has been enriched to conform to the requirements of this Act.

(d) The term "President" means the President of the Louisiana State Board of Health.

(e) The term "person" means an individual, a corporation, a partnership, an association, a joint stock company, a trust, or any unincorporated organization.

(f) The term "appropriate federal agency" means the Federal Security Agency, or any agency or department or administrative federal officer charged with the enforcement of the Federal Food, Drug and Cosmetic Act.

Section 2. On and after the effective date of this Act it shall be unlawful for any person to manufacture, mix, compound, sell or offer for sale, for human consumption in this State, any flour (as above defined) unless the following vitamins and other ingredients are contained in each pound of such flour:

(a) Not less than 1.66 milligrams of Vitamin B^1 (thiamin); not less than 6 milligrams of nicotinic acid (also recognized under the name of niacin) or nicotinic acid amide (also known under the name of niacin amide); and not less than 6 milligrams of iron (Fe). (These ingredients and amounts are in accordance with the definition of enriched flour as promulgated by the Federal Security Agency [Federal Register, Vol. 6, pp. 2579-82, May 27, 1941; and Vol. 6, pp. 6175-76, December 3, 1941, postponing the effective date of the addition of riboflavin as a required ingredient to enriched flour].)

(b) The enrichment of flour shall be accomplished by a milling process, addition of vitamins from natural or synthetic sources, addition of minerals, or by a combination of these methods or by any method which is permitted by the Federal Security Agency with respect to flour introduced into interstate commerce.

(c) The Louisiana State Board of Health is empowered with the authority and directed to change, or add to, the specifications for ingredients and the amounts thereof required to conform to the State or Federal definition of enriched flour when promulgated or as may be from time to time amended.

(d) If other vitamins or minerals are added to flour they shall be added only in accordance with the regulations of the Federal Security Agency.

(e) Iron shall be added only in forms which are assimilable and harmless and which do not impair the enriched flour.

Provided, however, that the terms of this Act shall not apply to flour sold to bakers or other commercial secondary processors, if, prior to or simultaneously with delivery, the purchaser furnishes to the seller a certificate of intent in such form as the President shall by regulation prescribe certifying that such flour shall be used only in the production of flour or bread enriched within the given establishment to meet the re-

quirements of this Act or shall be used in the manufacture of products other than flour or bread. It shall be unlawful for any such purchaser so furnishing any such certificate of intent to use the unenriched flour so purchased in any manner other than as stated in the certificate.

(f) The terms of this Act shall not apply to flour or bread which is made from the entire wheat berry with no parts of the wheat removed from the mixture. In cases of flour or bread containing mixtures of the whole wheat berry and white flour or mixture of various portions of the wheat berry such products shall have a vitamin and mineral potency at least equal to enriched flour or enriched bread as described herein.

(g) The terms of this Act shall not apply to flour ground for the wheat producer whereby the miller is paid in wheat or feed for the grinding services rendered, except insofar as such a mill may manufacture toll wheat into flour and sell or offer for sale such flour, whereupon this Act shall be applicable, nor shall the provisions of this Act apply to farmers in exchanging their wheat or flour, or having the same ground into flour and disposing of the same for their own use, or the use of farm labor on their farms.

Section 3. On and after the effective date of this Act it shall be unlawful for any person to manufacture, bake, sell or offer for sale, or to receive in interstate shipment for sale for human consumption in this State, any bread (as above defined) unless the following vitamins and other ingredients are contained in each pound of such bread:

(a) Not less than 1.0 milligram of Vitamin B^1 (thiamin); not less than 4.0 milligrams of nicotinic acid (niacin) or nicotinic acid amide (niacin amide); and not less than 4.0 milligrams of iron (Fe);

(b) The Louisiana State Board of Health is empowered with the authority and directed to change, or add to, the specifications for ingredients and the amounts thereof required to conform to the Federal definition of enriched bread when promulgated or as from time to time amended.

Section 4.

(a) The enrichment of bread may be accomplished through the use of enriched flour, enriched yeast, other enriched ingredients, synthetic vitamins, harmless iron salts or by any combination of harmless methods which will produce enriched bread which meets the requirements of Section 3.

(b) Iron shall be added only in forms that are assimilable and harmless and which do not impair the enriched bread.

Section 5. It shall be unlawful to sell or offer for sale in this State any enriched flour or enriched bread which fails to conform to the labeling of the State Food, Drug and Cosmetic Law (Act 142, 1936) and of the Federal Food, Drug and Cosmetic Act, and the regulations promulgated thereunder by the appropriate federal or state agency, with respect to flour or bread introduced into interstate commerce.

Section 6.

(a) The State Board of Health is authorized as the administrative agency and is hereby directed:

(1) To make, amend and rescind such rules and regulations as may be necessary to carry out the provisions of this Act, including, but without being limited to, such orders, rules, and regulations as it is hereinafter specifically authorized and directed to make.

(2) From time to time to adopt such regulations changing or adding to the required ingredients for flour or bread specified in Sections 2 and 3 as shall be necessary to conform to the definitions and standards of identity of enriched flour and enriched bread from time to time promulgated by the appropriate federal agency pursuant to the Federal Food, Drug and Cosmetic Act.

(b) In the event of the finding by the State Board of Health that there is an existing shortage or imminent shortage of any ingredient required by Section 2 and 3 of this Act, with the result that the sale and distribution of flour or bread may be substantially impeded by the enforcement of this Act, the State Board of Health shall issue an order, to be effective immediately upon issuance, permitting the omission of such ingredients from flour and bread. Whenever the State Board of Health finds that such shortage no longer exists, it shall issue an order, to be effective not less than ten (10) days after publication thereof, revoking such order. Any such findings as to the existence or imminence of any such shortage, or the cessation thereof, may be made by the State Board of Health without any hearing, on the basis of an order of, or factual information supplied by the appropriate federal agency (as hereinabove defined) or the War Production Board or any similar federal agency. In the absence of any such order or factual information the State Board of Health, upon receiving the sworn statement of any persons subject to this Act that such a shortage exists or is imminent or has ceased, shall, within ten (10) days thereafter, hold a public hearing with respect thereto, at which time any interested person may present evidence in support of such sworn statement, and any such finding by the State Board of Health may be based upon the evidence so presented. The State Board of Health shall publish notice of any such hearing at least ten (10) days prior thereto.

(c) All orders, rules, and regulations adopted by the State Board of Health pursuant to this Act shall be published in the manner hereinafter prescribed and, within the limits specified by this Act, shall become effective upon such date as the State Board of Health shall fix.

(d) Whenever under this Act publication of any notice, order, rule or regulation is required, such publication shall be made at least three (3) times in ten (10) days in newspapers of general circulation in three (3) different sections of the state.

(e) The President is authorized to collect samples for analysis and to conduct examinations and investigations for the purposes of this Act, through any officers or employees under his supervision; and all such officers and employees shall have authority to enter to inspect any factory, mill, warehouse, shop, or establishment where flour or bread is manufactured, processed, packed, sold, or held, or any vehicle and any flour or bread therein and all pertinent equipment, materials, containers and labeling.

Section 7. Any person who violates any of the provisions of this Act,

or the orders, rules or regulations promulgated by the State Board of Health under authority thereof, shall, upon conviction thereof, be subject to fine for each and every offense, in a sum not exceeding $100.00, or to imprisonment for not more than 30 days, or both such fine and imprisonment.

Section 8. All Acts and parts of Acts inconsistent with the provisions of this Act are hereby repealed to the extent of such inconsistency.

Section 9. If any provisions of this Act or the application thereof to any persons or circumstances is held invalid, such invalidity shall not affect other provisions or applications of this Act which can be given effect without the invalid provision or application, and to this end the provisions of this Act are declared to be severable.

Section 10. Active enforcement of this Act shall be deferred until October 1, 1942.

Approved by the Governor July 11, 1942.

A true copy:

JAS. A. GREMILLION,
Secretary of State.

REGULATIONS PROMULGATED UNDER AUTHORITY OF ACT 202 OF 1942

THE LOUISIANA ENRICHED FLOUR AND BREAD LAW

Regulation 1.00—All enriched flour shall be labeled as "Enriched Flour."

1.01—The addition of enriching ingredients to flour other than those required by Açt 202 of 1942 shall be limited to: (a) Vitamin D, not less than 250 U.S.P. units nor more than 1,000 U.S.P. units per pound; (b) Calcium (Ca), not less than 500 milligrams nor more than 2,000 milligrams per pound, except that enriched flour may be acidified with mono calcium phosphate irrespective of the minimum limit for calcium (Ca) herein prescribed; (c) Wheat germ or partly defatted wheat germ, not more than 5% by weight. When any such ingredient is added the kind and amount shall be plainly stated on the label.

1.02—When any reference is made on the labeling of flour to the kinds and amounts of enriching ingredients which have been added, such reference shall be limited to show the proportion of the average adult's daily requirements of such substances.

1.03—Enriched flour labels shall not contain claims regarding physiological or therapeutic effects of enriching ingredients nor information concerning other minerals or vitamins; except, that self-rising flour or phosphated flour shall list the kinds and amounts of added chemicals as required by Act 181 of 1936 (Self-Rising Flour Law.)

Regulations 2.00—Bakers or other commercial secondary processors purchasing unenriched flour shall furnish the seller with a certificate of intent, certifying that the unenriched flour will be used only in the production of flour or bread enriched within the purchaser's establishment in compliance with the law and these regulations. The certificate shall show, in addition to any other information contained therein, the name and address of the purchaser, the name and address of the seller, the effective date. and the purchase or purchases covered by the certificate.

2.01—The certificate shall be made in triplicate. The seller shall be given one copy, one copy shall be forwarded to the State Board of Health and one shall be retained by the purchaser.

2.02—The certificate shall be in one of two forms:

(a) A continuing certificate covering all purchases from each seller for an indefinite period of time and specifying that the certificate shall remain in force until notice is given in writing of its cancellation.

(b) A certificate covering a single purchase order, in which case the certificate shall specify the exact quantity of flour covered by the certificate, the trade or brand names, or other identifying marks on the flour containers, and any other information needed to identify the flour as that covered by the certificate.

Regulation 3.00—All enriched bread, when wrapped, shall be labeled "Enriched Bread."

3.01—The addition of enriching ingredients to bread, other than those required by Act 202 of 1942, shall be limited to: (a) Vitiman D, not less than 160 U.S.P. units nor more than 640 U.S.P. units per pound; (b) Calcium (Ca), not less than 333 milligrams nor more than 1,333 milligrams per pound, except that enriched bread may be acidified with mono calcium phosphate irrespective of the minimum limit for Calcium (Ca) herein prescribed; (c) Wheat germ or partly defatted wheat germ, but in no case shall the total quantity thereof be more than the quantity which may be present as a result of the use of enriched flour. When any such ingredient is added the kind and amount shall be plainly stated on the label.

3.02—When any reference is made on the labeling of bread to the kinds and amounts of enriching ingredients which have been added, such reference shall be limited to show the proportion of the average adult's daily requirements of such substances.

3.03—Enriched bread labels shall not contain claims regarding physiological or therapeutic effects of enriching ingredients nor information concerning other minerals or Vitamins.

Regulation 4.00—Any flour mill, flour warehouse, wholesale flour dealer's establishment, or any other place where flour may be milled, stored, distributed or offered for sale, or any bakery, bakery warehouse or secondary flour processing establishment in Louisiana shall be subject to inspection by an authorized representative of the State Board of Health at any reasonable time during working hours to determine whether flour or bread stocks are in compliance with the law or these regulations.

SUPPLEMENT III

Enrichment of Oleomargarine

ACT No. 203 OF 1942

House Bill No. 837 | By Mr. Toler (By Request)

AN ACT

To regulate the sale, distribution or possession of, and to require the enrichment of oleomargarine by the addition of vitamins; specifying ingredients and authorizing the State Board of Health to change or add to the specifications for such ingredients, and to determine the availability thereof; fixing active enforcement date of this Act, and to fix penalties for the violation of same; repealing all laws or parts of laws inconsistent with this Act.

Be it enacted by the Legislature of the State of Louisiana:

Whereas, Oleomargarine, both plain and enriched, is widely used as an edible fat and as a substitute for butter which always contains at least some Vitamin A even during the winter season, and unenriched oleomargarine, although a wholesome food, does not contain Vitamin A, it is, therefore, necessary and advisable to protect the health of the people of the State of Louisiana from a deficiency of this vitamin by providing for the addition of Vitamin A to oleomargarine in amounts which will make its Vitamin A potency equal to that of good butter.

Section 1. Be it enacted by the Legislature of Louisiana that on and after the passage of this Act it shall be unlawful for any manufacturer, processor or dealer in oleomargarine in the State of Louisiana to sell or offer for sale any such product within this State which does not contain at least 9,000 United States Pharmacopoeia Units of Vitamin A per pound.

Section 2. The State Board of Health is authorized as the administrative agency and is hereby authorized and directed to change, or add to, the specifications for ingredients and the amounts thereof required to conform to any changes in the ruling of the Federal Security Agency concerning the addition of vitamins to oleomargarine, established in the Federal Register, Vol. 6, pp. 2761-63, June 7, 1941, or as may be from time to time amended.

Section 3. The State Board of Health is empowered and directed to enforce this Act through the President of the State Board of Health or his other officers or agents and to enter upon the premises of any manufacturer, processor or refiner, or upon the premises of any person engaged as a retail or wholesale dealer in oleomargarine, for the purpose of collecting samples for analyses or making such

investigations as may be necessary to properly enforce the same. Any person found by a Court of competent jurisdiction to be guilty of violating the terms of this Act shall be punishable by a fine of not more than One Hundred ($100.00) Dollars, or by imprisonment for not more than thirty days for each and every offense.

Section 4. Whenever any person, firm or corporation subject to the provisions of this Act shall submit to the President of the State Board of Health an affidavit claiming a shortage or imminence of shortage of any vitamin added to or to be added to oleomargarine as required by this Act, the Louisiana State Board of Health shall request information from the War Production Board or other Federal agency responsible for information concerning said availability. If factual information from said source can be obtained within ten days this information shall be considered as final and the State Board of Health is hereby instructed to act thereon. However, if said information is not available within the prescribed time the State Board of Health shall call for a public hearing to be held within ten days after notice. If the testimony presented shows that the sale and distribution of oleomargarine may be substantially impeded by the enforcement of the provisions of this Act, it shall authorize the sale and distribution of oleomargarine until adequate supplies of such vitamins become available in the judgment of the State Board of Health, based on information from said Federal agencies or testimony at a public hearing.

Section 5. All oleomargarine sold in the State of Louisiana must be labeled in accordance with the State Food, Drug and Cosmetic Law (Act 142 of 1936) and with the regulations of the Federal Security Agency governing the labeling of oleomargarine with added Vitamin A sold interstate trade.

Section 6. All Acts or parts of Acts inconsistent with the provisions of this Act are hereby repealed to the extent of such inconsistency.

Section 7. If any provision of this Act or the application thereof to any person or circumstances is held invalid, such invalidity shall not affect other provisions or applications of this Act which can be given effect without the invalid provision or application, and to this end the provisions of this Act are declared to be severable.

Section 8. Active enforcement of this Act shall be deferred until October 1, 1942.

Approved by the Governor July 11, 1942.

A true copy:

JAS. A. GREMILLION,

Secretary of State.